

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

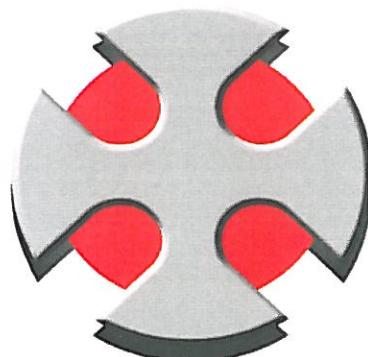
## CATHARE

### CATHARE 2 V2.5\_3mod2.1 : DICTIONARY OF DIRECTIVES AND OPERATORS

CSSI

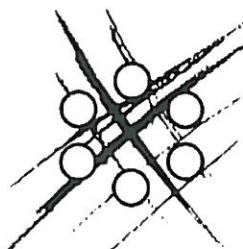
DEN/DANS/DM2S/STMF/LMES/RT/12-040/A

Décembre 2012



		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 1/851

**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**



Rapport technique DEN

***CATHARE 2 V2.5\_3mod2.1 : DICTIONNAIRE DES  
 OPERATEURS ET DIRECTIVES***

***CATHARE 2 V2.5\_3mod2.1 : DICTIONARY OF DIRECTIVES  
 AND OPERATORS***

DEN/DANS/DM2S/STMF/LMES/RT/12-040/A

CSSI

Commissariat à l'énergie atomique et aux énergies alternatives

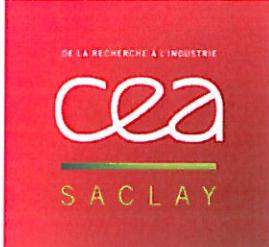
Centre : SACLAY

Adresse : 91191 Gif/Yvette Cedex

Tél. : 01 69 08 91 12 Fax : 01 69 08 96 96 Courriel : [bernard.faydide@cea.fr](mailto:bernard.faydide@cea.fr)

Établissement public à caractère industriel et commercial

RCS Paris B 775 685 019

 <b>ceasaclay</b> DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
<b>Document technique DEN</b>		Page 2/851

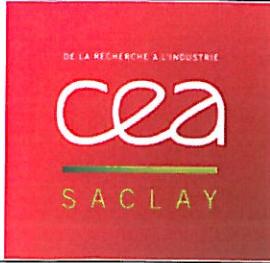
<b>NIVEAU DE CONFIDENTIALITE</b>				
DO	DR	CCEA	CD	SD
X				

PARTENAIRES/CLIENTS	ACCORD	TYPE D'ACTION
CEA - AREVA NP – EDF - IRSN	C7102	Quadripartite

<b>REFERENCES INTERNES CEA</b>			
DIRECTION D'OBJECTIFS	DOMAINE	PROJET	EOTP
DISN	Programme simulation	SITHY	A-SITHY-06-01-02-
JALON	INTITULE DU JALON	DELAI CONTRACTUEL DE CONFIDENTIALITE	CAHIERS DE LABORATOIRE

<b>SUIVI DES VERSIONS</b>			
INDICE	DATE	NATURE DE L'EVOLUTION	PAGES, CHAPITRES
<b>A</b>	14/12/2012	Emission initiale	851, 262

	NOM	FONCTION	CS SYSTEMES D'INFORMATION	DATE
REDACTEUR	CSSI	Ingénieur	6 Rue d'Arcelle - ZI des Plans - F 33000 BORDEAUX Tél. (33) 04 76 85 00 00 - Fax 04 76 85 00 01	12/12/12
VERIFICATEUR	G. LAVIALLE	Ingénieur	RCS Cérebral 393 135 298	12/12/12
CONTROLE QSE	D. DUMONT	Correspondant qualité	<i>D. Dumont</i>	12/12/2012
APPROBATEUR	P. EMONOT	Chef du LMES	<i>P. Emonot</i>	12/12/12
EMETTEUR	B. FAYDIDE	Chef du STMF	<i>B. Faydide</i>	17/12/2012

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	Page 3/851

#### MOTS CLEFS

CATHARE V2.5\_2, INSTALLATION

#### RESUME / CONCLUSIONS

Ce document est conçu comme un outil pratique visant à aider l'utilisateur dans la construction de ses jeux de données CATHARE 2 V2.5\_3mod2.1. En tête de document, un index thématique permet d'acquérir une vue d'ensemble des potentialités du code. Ensuite, l'ensemble des opérateurs et directives supportés par le code est classé par ordre alphabétique. Chaque section fournit pour l'opérateur ou la directive concerné, en premier une brève description de l'objet créé ou de la commande réalisée, une liste de mots clés associés puis le détail complet de la syntaxe reconnue par le code. Finalement, chaque section fournit un complément d'aide par des exemples simples d'utilisation.

#### ABSTRACT :

This document is a practical tool designed to help the user in building CATHARE 2 V2.5\_3mod2.1 input decks. The first section includes a thematic index providing a general overview of all code features. The whole set of operators and directives supported by the code are organized in alphabetical order. Each section provides for the given operator or directive, first a brief description of the object created or of the command performed, a list of associated keywords, then the fully detailed syntax recognized by the code. Finally, each section provides more help with simple examples.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 4/851

## DIFFUSION

### DIFFUSION EXTERNE

(Uniquement par fichier PDF courriel)

EDF/SEPTEN	T. POLACK, J.L. VACHER, B.F. FAIVRE, M TOMASELLO,
EDF/R&D (Chatou)	O. MARCHAND, A. SOUYRI
AREVA-NP	J.Y. SAUVAGE, J.L.GANDRILLE, L. CATALANI, A. CAILLAUX
IRSN/DPAM (Cad)	J. FLEUROT, F. BARRE
IRSN/DSR (Far)	Ph. DUFEIL, R. FREITAS

### DIFFUSION INTERNE CEA

(Uniquement par fichier PDF courriel)

DPIE/SA2P (Saclay)	M. RAEPSAET
DEN/DISN	J.P. DEFFAIN, D. CARUGE
DEN/DER/SES	J.C. GARNIER, S. DARDOUR
DEN/DANS/DM2S/SERMA	M. BLANC-TRANCHANT
DEN/DANS/DM2S	E. PROUST, Ph. MONTARNAL
DEN/DANS/DM2S/STMF	B. FAYDIDE, F. DUCROS
DEN/DANS/DM2S/STMF/LATF	D. GALLO
DEN/DANS/DM2S/STMF/LGLS	V. BERGEAUD
DEN/DANS/DM2S/STMF/LIEFT	F. FAYDIDE
DEN/DANS/DM2S/STMF/LMEC	D. JAMET, M. CHANDESRIS
DEN/DANS/DM2S/STMF/LMSF	O. ANTONI
DEN/DANS/DM2S/STMF/LMES	P. EMONOT, tous les salariés du LMES

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 5/851

## CONTENTS

### Contents

<b>CONTENTS .....</b>	<b>5</b>
<b>DICTIONARY INDEX .....</b>	<b>21</b>
<b>LIST OF FIGURES .....</b>	<b>30</b>
<b>1 ACCUMOD DIRECTIVE .....</b>	<b>31</b>
<b>2 ACCU OPERATOR .....</b>	<b>33</b>
2.1 ACCU on an AXIAL element .....	33
2.2 ACCU on a VOLUME element .....	33
<b>3 ACTEMIS DIRECTIVE .....</b>	<b>37</b>
<b>4 ADIABWAL DIRECTIVE .....</b>	<b>38</b>
<b>5 ALWMIN DIRECTIVE .....</b>	<b>40</b>
<b>6 AND OPERATOR .....</b>	<b>41</b>
6.1 Case of fuel .....	41
6.2 Case of logical .....	42
<b>7 ASSIGN DIRECTIVE .....</b>	<b>43</b>
7.1 ASSIGN directive for a Rupture .....	43
7.1.1 For an internal rupture : outside data are given through laws function of time .....	43
7.1.2 For an external rupture : in this case user can access to imposed values through CCV .....	44
7.2 ASSIGN directive for an AXIAL .....	47
<b>8 AXIAL GROUP OPERATOR .....</b>	<b>49</b>
<b>9 AXIAL OPERATOR .....</b>	<b>51</b>
<b>10 AXICOND DIRECTIVE .....</b>	<b>52</b>
10.1 Activation of the AXICOND directive .....	52
10.2 Deactivation of the AXICOND directive .....	52
<b>11 BCMOD DIRECTIVE .....</b>	<b>53</b>
<b>12 BCCONDIT GROUP OPERATOR .....</b>	<b>56</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 6/851

<b>13 BCONDIT OPERATOR .....</b>	<b>57</b>
<b>14 BEGIN DATA DIRECTIVE .....</b>	<b>58</b>
<b>15 BILAN3D DIRECTIVE.....</b>	<b>59</b>
<b>16 BLKROTOR DIRECTIVE.....</b>	<b>61</b>
<b>17 BREAK OPERATOR.....</b>	<b>62</b>
<b>18 BRUTEF77 DIRECTIVE.....</b>	<b>64</b>
<b>19 BYPASS DIRECTIVE.....</b>	<b>66</b>
<b>20 CANDLE OPERATOR .....</b>	<b>70</b>
<b>21 CATAFUEL OPERATOR.....</b>	<b>74</b>
<b>22 CCFL OPERATOR.....</b>	<b>78</b>
<b>23 CHAR8 DIRECTIVE.....</b>	<b>81</b>
<b>24 CHECK VALVE OPERATOR .....</b>	<b>82</b>
<b>25 CIRCUIT OPERATOR.....</b>	<b>85</b>
<b>26 CLOSE DIRECTIVE .....</b>	<b>87</b>
<b>27 CLOSEGAP DIRECTIVE .....</b>	<b>88</b>
<b>28 COMETE DIRECTIVE .....</b>	<b>89</b>
<b>29 COMPHYD DIRECTIVE.....</b>	<b>90</b>
<b>30 COMPONEN(T) OPERATOR .....</b>	<b>91</b>
30.1 Shell side of the heat exchanger .....	92
30.2 Finned side of a heat exchanger .....	94
30.3 Side of a Printed Circuit Heat exchanger .....	95
30.4 Bundle side of a helicoid tube bundle heat exchanger .....	95
30.5 Plate type hydraulic core .....	96
30.6 Pin type hydraulic core .....	96
30.7 User correlations .....	98
30.8 The leak-before-break (LBB) axial element .....	99
<b>31 CONNECT DIRECTIVE .....</b>	<b>101</b>
31.1 CONNECT for a TEE .....	101
31.2 CONNECT for a THREED .....	102
<b>32 CONTROL ROD GROUP OPERATOR .....</b>	<b>110</b>
<b>33 CONTROL ROD MECHA OPERATOR.....</b>	<b>114</b>
<b>34 CONTROL-VALVE OPERATOR .....</b>	<b>116</b>
<b>35 CORE OPERATOR .....</b>	<b>119</b>
<b>36 DEGRE OPERATOR .....</b>	<b>127</b>
<b>37 DISABLE DIRECTIVE .....</b>	<b>128</b>

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SA CLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 7/851

<b>38 DOUBLE DIRECTIVE .....</b>	<b>129</b>
<b>39 DTMASS3D DIRECTIVE .....</b>	<b>130</b>
<b>40 ECHECK OPERATOR .....</b>	<b>131</b>
<b>41 ECHPOWER DIRECTIVE .....</b>	<b>133</b>
<b>42 ECVALVE OPERATOR .....</b>	<b>134</b>
<b>43 ELSE DIRECTIVE .....</b>	<b>136</b>
<b>44 ENABLE DIRECTIVE .....</b>	<b>137</b>
<b>45 END DIRECTIVE .....</b>	<b>139</b>
<b>46 ENDIF DIRECTIVE .....</b>	<b>140</b>
<b>47 EQ OPERATOR .....</b>	<b>141</b>
<b>48 EXCHANGER OPERATOR .....</b>	<b>142</b>
48.1 Explicit exchanger between two circuits .....	143
48.2 Quasi implicit exchanger .....	151
48.2.1 Quasi implicit exchanger on an 1-D element .....	151
48.2.2 Quasi implicit exchanger on an 3-D element .....	153
<b>49 EXCPOWER DIRECTIVE .....</b>	<b>158</b>
<b>50 EXHYLINK OPERATOR .....</b>	<b>160</b>
50.1 Communication modes .....	160
50.2 Exchange informations .....	161
50.3 Available configurations .....	162
<b>51 EXP OPERATOR .....</b>	<b>164</b>
<b>52 EXWALINK OPERATOR .....</b>	<b>165</b>
<b>53 FASTSIZE DIRECTIVE .....</b>	<b>170</b>
<b>54 FLOMIXER OPERATOR .....</b>	<b>171</b>
<b>55 FLOMIXER ZOOM OPERATOR .....</b>	<b>173</b>
<b>56 FLOW-LIMITER OPERATOR .....</b>	<b>177</b>
<b>57 FLUID OPERATOR .....</b>	<b>179</b>
<b>58 FLUMOD DIRECTIVE .....</b>	<b>181</b>
<b>59 FUEL3D OPERATOR .....</b>	<b>184</b>
<b>60 FUELCHAR GROUP OPERATOR .....</b>	<b>192</b>
<b>61 FUELCHAR OPERATOR .....</b>	<b>194</b>
<b>62 FUELDTMX DIRECTIVE .....</b>	<b>202</b>
<b>63 FUEL OPERATOR .....</b>	<b>205</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 8/851

<b>64 FUELPLAQ OPERATOR .....</b>	<b>214</b>
64.1 PWR and NP Navy power Plant applications.....	215
64.2 HTR application .....	217
64.3 FNR application .....	219
<b>65 GEOM DIRECTIVE .....</b>	<b>252</b>
65.1 Geometry of an <b>1-D</b> element.....	252
65.1.1 Standard application .....	252
65.1.2 Case of (LBB) Leak-Before-Break application .....	253
65.2 Geometry of an <b>TEE</b> -branch element .....	255
65.3 Geometry of an <b>0-D</b> element .....	258
65.3.1 Standard <b>0-D</b> module.....	258
65.3.2 Separator <b>0-D</b> module .....	259
65.3.3 Dryer <b>0-D</b> module .....	260
65.4 Geometry of an <b>3-D</b> element.....	266
<b>66 GOBALLON DIRECTIVE .....</b>	<b>272</b>
<b>67 GOBORA DIRECTIVE .....</b>	<b>274</b>
<b>68 GODIFF DIRECTIVE .....</b>	<b>276</b>
<b>69 GOFUEL DIRECTIVE .....</b>	<b>277</b>
<b>70 GONEUT DIRECTIVE .....</b>	<b>279</b>
<b>71 GOPERM DIRECTIVE .....</b>	<b>281</b>
<b>72 GOTURB DIRECTIVE .....</b>	<b>282</b>
<b>73 GUI_DAT OPERATOR .....</b>	<b>283</b>
<b>74 GVPPOWER DIRECTIVE .....</b>	<b>284</b>
<b>75 HTCBACON DIRECTIVE .....</b>	<b>286</b>
<b>76 HTCBYHL DIRECTIVE .....</b>	<b>287</b>
<b>77 HYDCHAN OPERATOR .....</b>	<b>288</b>
<b>78 HYDIMP OPERATOR .....</b>	<b>289</b>
<b>79 HYDMOD DIRECTIVE .....</b>	<b>291</b>
<b>80 HYDRCOM DIRECTIVE .....</b>	<b>293</b>
<b>81 HYDR DIRECTIVE .....</b>	<b>295</b>
81.1 Hydraulic geometry of a <b>1-D</b> element.....	295
81.2 Hydraulic geometry of a <b>3-D</b> element.....	297
<b>82 HYDRMOD DIRECTIVE .....</b>	<b>303</b>
<b>83 IF DIRECTIVE .....</b>	<b>304</b>
<b>84 IMOSFLOW DIRECTIVE .....</b>	<b>305</b>
<b>85 IMOSXI DIRECTIVE .....</b>	<b>307</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 9/851

<b>86 IMPRIME DIRECTIVE .....</b>	<b>309</b>
<b>87 INIBIL DIRECTIVE .....</b>	<b>310</b>
<b>88 INIBORA DIRECTIVE.....</b>	<b>311</b>
<b>89 INISIM DIRECTIVE.....</b>	<b>317</b>
<b>90 INTEGER DIRECTIVE .....</b>	<b>318</b>
<b>91 INTEGRATE DIRECTIVE .....</b>	<b>319</b>
<b>92 INTERP OPERATOR .....</b>	<b>320</b>
<b>93 JUNCTION GROUP OPERATOR .....</b>	<b>321</b>
<b>94 LAW OPERATOR .....</b>	<b>323</b>
<b>95 LEVEL DIRECTIVE .....</b>	<b>324</b>
<b>96 LINK DIRECTIVE .....</b>	<b>326</b>
<b>97 LIST DIRECTIVE .....</b>	<b>327</b>
<b>98 LOCATE3D OPERATOR.....</b>	<b>329</b>
<b>99 LOG OPERATOR .....</b>	<b>330</b>
<b>100 LOWPRESS DIRECTIVE .....</b>	<b>331</b>
<b>101 MANAGE DIRECTIVE .....</b>	<b>332</b>
<b>102 MANIFOLD DIRECTIVE .....</b>	<b>334</b>
<b>103 MATERIAL OPERATOR .....</b>	<b>337</b>
<b>104 MATHEMATICAL OPERATORS .....</b>	<b>339</b>
104.1 * OPERATOR .....	339
104.2 ** OPERATOR .....	340
104.3 + OPERATOR .....	341
104.4 - OPERATOR .....	342
104.5 / OPERATOR .....	343
104.6 < OPERATOR .....	344
104.7 <EQ OPERATOR .....	345
104.8 > OPERATOR .....	346
104.9 >EQ OPERATOR .....	347
104.10 ABSOLUTE OPERATOR .....	348
<b>105 MAX OPERATOR .....</b>	<b>349</b>
<b>106 MESH DIRECTIVE .....</b>	<b>350</b>
106.1 Meshing of a 1-D element .....	350
106.2 Meshing of a 3-D element .....	351
<b>107 MESSAGE DIRECTIVE .....</b>	<b>357</b>
<b>108 MIN OPERATOR .....</b>	<b>358</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 10/ <a href="#">851</a>

<b>109 MODEL DIRECTIVE</b> .....	<b>359</b>
109.1 <b>BLIND</b> model .....	361
109.2 <b>BC3x</b> Internal type (inlet type conditions) .....	361
109.3 <b>BC3</b> External type (inlet type conditions) .....	364
109.4 <b>BC4x, BC5x</b> Internal type (outlet type conditions) .....	365
109.4.1 <b>BC4A</b> Model .....	365
109.4.2 <b>BC4B</b> Model .....	366
109.4.3 <b>BC4C</b> Model .....	366
109.4.4 <b>BC5A</b> Model .....	366
109.4.5 <b>BC5B</b> Model .....	366
109.5 <b>BC4x, BC5x</b> External type (outlet type conditions) .....	368
109.5.1 <b>BC4A</b> Model .....	368
109.5.2 <b>BC4C</b> Model .....	368
109.5.3 <b>BC5A</b> Model .....	368
109.5.4 <b>BC5B</b> Model .....	368
109.6 <b>BC5XX, BC5ZZ, BC5YY</b> (Internal type model ) .....	369
109.6.1 <b>BC5XX</b> .....	369
109.6.2 <b>BC5ZZ</b> .....	369
109.6.3 <b>BC5YY</b> .....	370
109.7 <b>BC5XX or BC5ZZ</b> External type model .....	374
109.8 <b>SAFETYVA</b> Internal type model .....	376
109.9 <b>BC5HO</b> External type model .....	377
<b>110 MODGRAV DIRECTIVE</b> .....	<b>379</b>
<b>111 MODPCST DIRECTIVE</b> .....	<b>380</b>
<b>112 MODPNCST DIRECTIVE</b> .....	<b>381</b>
<b>113 MODXNEUT DIRECTIVE</b> .....	<b>382</b>
<b>114 MODXRES DIRECTIVE</b> .....	<b>384</b>
<b>115 MONOPHAS(E) DIRECTIVE</b> .....	<b>386</b>
<b>116 NEQ OPERATOR</b> .....	<b>388</b>
<b>117 NEWDT OPERATOR</b> .....	<b>389</b>
<b>118 NEW_SYNT DIRECTIVE</b> .....	<b>390</b>
<b>119 NEWTIME OPERATOR</b> .....	<b>391</b>
<b>120 NOFLOW DIRECTIVE</b> .....	<b>392</b>
<b>121 NONCOND OPERATOR</b> .....	<b>393</b>
<b>122 OLD_SYNT DIRECTIVE</b> .....	<b>396</b>
<b>123 OPENALL DIRECTIVE</b> .....	<b>397</b>
<b>124 OPENBREK DIRECTIVE</b> .....	<b>398</b>
124.1 <b>OPENBREK</b> for a PIQBREK in an AXIAL element .....	398
124.2 <b>OPENBREK</b> for a PIQBREK in a VOLUME element .....	399

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 11/851

124.3 OPENBREK for a SGTR .....	400
<b>125 OPEN DIRECTIVE .....</b>	<b>401</b>
<b>126 OPENFILE OPERATOR .....</b>	<b>403</b>
<b>127 OPTION DIRECTIVE .....</b>	<b>404</b>
<b>128 OR OPERATOR .....</b>	<b>408</b>
<b>129 OXRATE DIRECTIVE .....</b>	<b>409</b>
<b>130 PCAVIT DIRECTIVE .....</b>	<b>411</b>
<b>131 PERF DIRECTIVE .....</b>	<b>412</b>
<b>132 PERIOD DIRECTIVE .....</b>	<b>413</b>
<b>133 PERMIT DIRECTIVE .....</b>	<b>415</b>
<b>134 PESEE DIRECTIVE .....</b>	<b>424</b>
<b>135 PHYSCALE DIRECTIVE .....</b>	<b>425</b>
135.1 Hydraulic scale for mesh cell volume .....	425
135.2 Hydraulic scale for mesh cell face .....	426
<b>136 PICTG DIRECTIVE .....</b>	<b>429</b>
<b>137 PIQARE OPERATOR .....</b>	<b>431</b>
<b>138 PIQBREK OPERATOR .....</b>	<b>433</b>
138.1 PIQBREK on an <b>1-D</b> element .....	433
138.2 PIQBREK on a <b>0-D</b> element .....	434
<b>139 PIQREV OPERATOR .....</b>	<b>435</b>
139.1 PIQREV on an <b>1-D</b> element .....	435
139.2 PIQREV on a <b>0-D</b> element .....	437
139.3 PIQREV on a <b>3-D</b> element .....	438
<b>140 PIQSEB OPERATOR .....</b>	<b>439</b>
<b>141 PIQSOUP OPERATOR .....</b>	<b>443</b>
<b>142 PIQVANNE OPERATOR .....</b>	<b>445</b>
<b>143 PNRSHAPE AND PNRSHAPX DIRECTIVES .....</b>	<b>449</b>
<b>144 POUNC DIRECTIVE .....</b>	<b>452</b>
<b>145 POWER DIRECTIVE .....</b>	<b>454</b>
145.1 Modification of the power of a wall .....	454
145.2 Modification of the power of a fuel structure .....	455
<b>146 PRESHAPE AND PRESHAPX DIRECTIVES .....</b>	<b>457</b>
<b>147 PRIN3D DIRECTIVE .....</b>	<b>459</b>
<b>148 PRINSTRU DIRECTIVE .....</b>	<b>461</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 12/851

<b>149 PUMPCHAR OPERATOR .....</b>	<b>463</b>
<b>150 PUMPMOD DIRECTIVE .....</b>	<b>473</b>
<b>151 QUIT DIRECTIVE .....</b>	<b>477</b>
<b>152 RADCHEMI OPERATOR .....</b>	<b>479</b>
<b>153 RADIANT OPERATOR .....</b>	<b>482</b>
<b>154 RADIAT DIRECTIVE .....</b>	<b>483</b>
<b>155 REACTOR DIRECTIVE .....</b>	<b>485</b>
<b>156 REACTOR OPERATOR .....</b>	<b>486</b>
<b>157 READHCAT DIRECTIVE .....</b>	<b>487</b>
<b>158 READHEAD DIRECTIVE .....</b>	<b>489</b>
<b>159 READHEXT DIRECTIVE .....</b>	<b>491</b>
<b>160 READMIX DIRECTIVE .....</b>	<b>493</b>
160.1 Syntax of the READMIX directive .....	493
160.2 Format of the external file .....	494
<b>161 READVAR DIRECTIVE .....</b>	<b>498</b>
<b>162 REALAX DIRECTIVE .....</b>	<b>500</b>
<b>163 REALC DIRECTIVE .....</b>	<b>503</b>
<b>164 REALLIST OPERATOR .....</b>	<b>506</b>
<b>165 REALVO DIRECTIVE .....</b>	<b>508</b>
<b>166 REFLCH3D OPERATOR .....</b>	<b>511</b>
<b>167 REFLCHAR OPERATOR .....</b>	<b>512</b>
<b>168 REFLOOD DIRECTIVE .....</b>	<b>514</b>
<b>169 REINIT DIRECTIVE .....</b>	<b>515</b>
<b>170 RELOC DIRECTIVE .....</b>	<b>516</b>
<b>171 REPEAT DIRECTIVE .....</b>	<b>518</b>
<b>172 RESETIME DIRECTIVE .....</b>	<b>520</b>
<b>173 RESHCAT DIRECTIVE .....</b>	<b>522</b>
<b>174 RESTEST DIRECTIVE .....</b>	<b>523</b>
<b>175 RESTORE DIRECTIVE .....</b>	<b>525</b>
175.1 Restore after the pre-processing READER treatment .....	525
175.2 Restore after the kernel CATHARE computation .....	525
175.3 Restore after the CATHARE computation with a new input data deck .....	527

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 13/851

<b>176 RESULT DIRECTIVE</b>	<b>528</b>
<b>177 REWIND DIRECTIVE</b>	<b>530</b>
<b>178 ROCPELEM DIRECTIVE</b>	<b>531</b>
<b>179 ROROD DIRECTIVE</b>	<b>532</b>
<b>180 RSETFUEL DIRECTIVE</b>	<b>533</b>
<b>181 RUPTURE OPERATOR</b>	<b>535</b>
<b>182 SAVE DIRECTIVE</b>	<b>536</b>
<b>183 SCALAR OPERATOR</b>	<b>538</b>
<b>184 SCRAM DIRECTIVE</b>	<b>540</b>
<b>185 SEGMENT OPERATOR</b>	<b>541</b>
<b>186 SENSOR OPERATOR</b>	<b>543</b>
186.1 Temperature sensor	543
186.2 Wall temperature sensor	544
186.3 Pressure sensor	544
186.4 Flowrate sensor	545
186.5 Mailsipa sensor	545
186.6 Acti sensor	546
186.7 Actisipa sensor	546
186.8 Qactisipa sensor	547
186.9 Ultrason sensor	547
186.10 Swellevel sensor	548
<b>187 SGCARACT OPERATOR</b>	<b>550</b>
<b>188 SGFEED DIRECTIVE</b>	<b>552</b>
<b>189 SGTR OPERATOR</b>	<b>554</b>
<b>190 SHAFTMOD DIRECTIVE</b>	<b>557</b>
<b>191 SHAFT OPERATOR</b>	<b>559</b>
<b>192 SINGULAR DIRECTIVE</b>	<b>561</b>
192.1 Singularities of a <b>1-D</b> element	561
192.2 Singularities of a <b>TEE</b> -branch	563
192.3 Singularities of a <b>0-D</b> element	564
192.4 Singularities of a <b>3-D</b> element	565
<b>193 SINGUMOD DIRECTIVE</b>	<b>569</b>
193.1 Modification of singularities of a <b>1-D</b> element	569
193.2 Modification of singularities of a <b>0-D</b> element	570
<b>194 SINK OPERATOR</b>	<b>572</b>
194.1 <b>SINK</b> on a <b>1-D</b> element	572
194.2 <b>SINK</b> on a <b>0-D</b> element	573

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SA CLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 14/851

194.3 SINK with PURGE option for a turbine .....	575
<b>195 SINKRRI OPERATOR .....</b>	<b>576</b>
195.1 1 <sup>st</sup> case : The sinkrri contains a CCCW circuit and two or three exchangers .....	576
195.2 2 <sup>nd</sup> case : The sinkrri contains only an CSS/SEB exchanger .....	579
<b>196 SOURCEMOD DIRECTIVE .....</b>	<b>583</b>
<b>197 SOURCE OPERATOR .....</b>	<b>586</b>
197.1 External source .....	588
197.2 Internal source .....	588
<b>198 SOURIS OPERATOR .....</b>	<b>598</b>
<b>199 SPALL DIRECTIVE .....</b>	<b>602</b>
<b>200 SPALLECR DIRECTIVE .....</b>	<b>603</b>
<b>201 SPALLOX DIRECTIVE .....</b>	<b>604</b>
<b>202 STARALTR DIRECTIVE .....</b>	<b>605</b>
<b>203 STAROVRF DIRECTIVE .....</b>	<b>606</b>
<b>204 STARPUMP DIRECTIVE .....</b>	<b>607</b>
<b>205 STARSHAF DIRECTIVE .....</b>	<b>609</b>
<b>206 STARSURG DIRECTIVE .....</b>	<b>610</b>
<b>207 STARTMIX DIRECTIVE .....</b>	<b>611</b>
<b>208 STARTVC DIRECTIVE .....</b>	<b>612</b>
<b>209 STDYFUEL DIRECTIVE .....</b>	<b>613</b>
<b>210 STOPACON DIRECTIVE .....</b>	<b>614</b>
<b>211 STOPALTR DIRECTIVE .....</b>	<b>615</b>
<b>212 STOPFUEL DIRECTIVE .....</b>	<b>616</b>
<b>213 STOPMIX DIRECTIVE .....</b>	<b>617</b>
<b>214 STOPNEUT DIRECTIVE .....</b>	<b>618</b>
<b>215 STOPOVRF DIRECTIVE .....</b>	<b>620</b>
<b>216 STOPPUMP DIRECTIVE .....</b>	<b>621</b>
<b>217 STOPSHAF DIRECTIVE .....</b>	<b>622</b>
<b>218 STOPSURG DIRECTIVE .....</b>	<b>623</b>
<b>219 STOPVC DIRECTIVE .....</b>	<b>624</b>
<b>220 STOPYHL DIRECTIVE .....</b>	<b>625</b>
<b>221 STOREHYD DIRECTIVE .....</b>	<b>626</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 15/851

<b>222 SWITCH DIRECTIVE .....</b>	<b>628</b>
222.1 Activation .....	628
222.2 Deactivation .....	629
<b>223 TABLE DIRECTIVE .....</b>	<b>631</b>
<b>224 TCOMCHAR OPERATOR .....</b>	<b>632</b>
224.1 TURBINE modeling .....	632
224.1.1 TURBINE modeling using specified pressure ratio and isentropic efficiency data .....	632
224.1.2 TURBINE modelind using specified head and torque data .....	634
224.2 COMPRESSOR modeling .....	635
224.2.1 COMPRESSOR modeling using specified pressure ratio and isentropic efficiency data .....	635
224.2.2 COMPRESSOR modeling using specified head and torque data .....	637
<b>225 TCOMMOD DIRECTIVE .....</b>	<b>649</b>
<b>226 TEE OPERATOR .....</b>	<b>651</b>
<b>227 THREED OPERATOR .....</b>	<b>652</b>
<b>228 TITLE DIRECTIVE .....</b>	<b>653</b>
<b>229 TOURNANT DIRECTIVE .....</b>	<b>654</b>
<b>230 TPER3D DIRECTIVE .....</b>	<b>656</b>
<b>231 TRANFUEL DIRECTIVE .....</b>	<b>657</b>
<b>232 TRANSENS DIRECTIVE .....</b>	<b>658</b>
<b>233 TRANSIENT DIRECTIVE .....</b>	<b>660</b>
<b>234 TRIGONOMETRIC FUNCTIONS .....</b>	<b>662</b>
234.1 Sinus .....	662
234.2 Cosinus .....	662
234.3 Tangent .....	662
234.4 Arcsinus .....	662
234.5 Arccosin .....	663
234.6 Arctangt .....	663
<b>235 TURBINE OPERATOR .....</b>	<b>664</b>
<b>236 TURBULEN DIRECTIVE .....</b>	<b>666</b>
<b>237 USE DIRECTIVE .....</b>	<b>667</b>
237.1 Assign a variable gravity .....	667
237.2 Specify a restart with a new input data deck .....	668
<b>238 UTIL1 TO UTIL20 DIRECTIVES .....</b>	<b>670</b>
<b>239 VALBA OPERATOR .....</b>	<b>671</b>
239.1 CCVs calculated in a CIRCUIT .....	672
239.2 CCVs calculated in an ELEMENT .....	674
239.3 CCVs calculated at a JUNCTION .....	677

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 16/851

239.4 CCVs calculated in a ZONE .....	678
239.5 CCVs calculated in a ZONE 3D .....	679
239.6 CCVs calculated in a PIQxxx gadget .....	680
239.7 CCVs in a SOURCE, a SINK or a BREAK .....	681
239.8 CCVs calculated in a SGTR .....	682
<b>240 VALUEFLD DIRECTIVE .....</b>	<b>683</b>
<b>241 VALUE OPERATOR .....</b>	<b>686</b>
241.1 CCVs for the USER common .....	687
241.2 CCVs calculated in a REACTOR .....	688
241.2.1 General variables .....	688
241.2.2 Variables for simulator use .....	688
241.2.3 Variables for user file use .....	688
241.2.4 Variables for COMETE application: .....	688
241.3 CCVs calculated in a CIRCUIT .....	689
241.4 CCVs calculated in an ELEMENT .....	690
241.4.1 General variables .....	690
241.4.2 Additional variables for AXIAL element .....	692
241.4.3 Variables for coupling with external codes: momentum and energy sources .....	693
241.4.4 Variables for sensitivity calculations .....	693
241.4.5 Additional variables for VOLUME element .....	694
241.4.6 Variables for FLOMIXER model .....	695
241.4.7 Variables for VFILM directive use .....	695
241.4.8 Variables for sensitivity calculation (volume only) .....	695
241.4.9 Variables for sensitivity calculation (for TEE element only) .....	696
241.4.10 Variables for a boundary condition and rupture element .....	696
241.4.11 Variables for external boundary condition BC3 BC4x BC5x and BC5XX .....	697
241.5 CCVs calculated in a JUNCTION .....	699
241.6 CCVs calculated in a ZONE .....	701
241.7 CCVs calculated in a ZONE 3D .....	702
241.8 CCVs calculated in a WALL .....	704
241.8.1 General variables .....	704
241.8.2 Variables for time and axial variation of power law .....	705
241.8.3 Variables for a WALLCOM type wall .....	705
241.8.4 Variables for sensitivity parameter .....	706
241.9 CCVs calculated in an EXCHANGER .....	708
241.9.1 General variables .....	708
241.9.2 Variables for time and axial variation of power law .....	708
241.9.3 Variables for sensitivity parameter .....	709
241.10 CCVs calculated in a FUEL WALL or FUELPLAQ (FUEL PLATE) .....	711
241.10.1 Variables accessible at any time .....	711
241.10.2 Variables accessible at any time only for FUEL FUELCHAR object .....	713
241.10.3 Variables accessible after GONEUT directive only for FUEL or FUELPLAQ objects .....	713
241.10.4 Variables accessible after GOFUEL directive only for FUELCHAR elements .....	713

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 17/851

241.11 CCVs calculated in a reflooding element (REFLCHAR) .....	716
241.11.1 General variables .....	716
241.11.2 Variables for sensitivity parameters .....	716
241.12 CCVs calculated in an ACCUMULATOR .....	717
241.13 CCVs calculated in a BREAK .....	718
241.14 CCVs calculated in a CANDLE .....	719
241.14.1 General variables .....	719
241.14.2 Variables for 1-D or 3-D element .....	719
241.14.3 Variables for 0-D element .....	719
241.15 CCVs calculated in a neutronic sub-module (CORE) .....	720
241.16 CCVs calculated in a Piqxxx gadget .....	721
241.16.1 Variables for all PIQxxx gadgets .....	721
241.16.2 Specific additional variables for PIQBREK .....	723
241.16.3 Specific additional variables for PIQSOUP .....	723
241.16.4 Specific additional variables for PIQSEB .....	723
241.16.5 Specific additional variables for PIQVANNE .....	724
241.16.6 Specific additional variables for PIQREV .....	725
241.16.7 Specific additional variables for PIQARE .....	725
241.17 CCVs calculated in a 0D PUMP .....	726
241.17.1 General variables .....	726
241.17.2 Variables for failure .....	726
241.17.3 Variables for asynchronous motor model .....	726
241.17.4 Variables for sensitivity parameter .....	727
241.18 CCVs calculated in a SENSOR .....	728
241.18.1 Variables for Temperature sensor .....	728
241.18.2 Variables for Pressure sensor .....	728
241.18.3 Variables for Flowrate sensor .....	728
241.18.4 Variables for SIPA simulator Sensor .....	728
241.18.5 Variables for Activity sensor .....	729
241.18.6 Variables for ACTISIPA Activity sensor .....	729
241.18.7 Variables for QACTSIPA Activity sensor .....	729
241.18.8 Variables for ULTRASON Sensor and for the measure of the level in the hot leg .....	729
241.18.9 Variables for SWLLEVEL Sensor used for the measure of the swell level .....	729
241.19 CCVs calculated in a SINK .....	732
241.19.1 General variables .....	732
241.19.2 Additional variables for a sink-safety valve .....	732
241.19.3 Additional variables for a RRI sink (type SINKRRI) .....	733
241.20 CCVs calculated in a SOURCE .....	734
241.20.1 General variables .....	734
241.20.2 Additional variables for a SOURIS type source .....	735
241.21 CCVs calculated in a 0D STEAM GENERATOR .....	736
241.22 CCVs calculated in a SGTR .....	737
241.22.1 Global variables .....	737
241.22.2 Partial variables .....	737

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 18/851

241.23 CCVs calculated in a turbomachine sub-module (TCOMCHAR) .....	739
241.24 CCVs calculated in a TURBINE .....	741
241.25 CCVs calculated in a CONTROL VALVE, a CHECK VALVE, a FLOW LIMITER, an ECVALVE or an ECHECK gadget.....	742
<b>242 VALUFEAU DIRECTIVE .....</b>	<b>744</b>
<b>243 VALVE DIRECTIVE .....</b>	<b>745</b>
<b>244 VECTOR OPERATOR .....</b>	<b>747</b>
<b>245 VERBOSE DIRECTIVE .....</b>	<b>749</b>
<b>246 VFILM DIRECTIVE .....</b>	<b>751</b>
<b>247 VOLUME OPERATOR .....</b>	<b>754</b>
<b>248 WALL3D OPERATOR .....</b>	<b>756</b>
<b>249 WALLCOM OPERATOR .....</b>	<b>764</b>
<b>250 WALL GROUP OPERATOR .....</b>	<b>767</b>
<b>251 WALLMOD DIRECTIVE .....</b>	<b>769</b>
<b>252 WALL OPERATOR .....</b>	<b>771</b>
252.1 WALL on a <b>1-D</b> element .....	771
252.2 Wall on a <b>TEE</b> -branch element .....	784
252.3 Wall on a <b>0-D</b> element .....	784
<b>253 WCIRCBIA DIRECTIVE .....</b>	<b>790</b>
<b>254 WRIBA DIRECTIVE .....</b>	<b>792</b>
254.1 CCVs imposed in an ELEMENT .....	793
254.2 CCVs imposed in a PIQxxx gadget .....	795
254.3 CCVs imposed in a SOURCE .....	796
<b>255 WRITE DIRECTIVE .....</b>	<b>797</b>
255.1 CCVs imposed in the USER common .....	798
255.1.1 Activation of XUSER, KUSER, CUSER arrays .....	798
255.1.2 Filling of the USER common .....	798
255.2 CCVs imposed in a REACTOR .....	799
255.3 CCVs imposed in an ELEMENT .....	800
255.3.1 General variables .....	800
255.3.2 Variables for sensitivity parameters .....	801
255.3.3 Additional variables for <b>1-D</b> .....	804
255.3.4 Variables for coupling with external codes: momentum and energy sources .....	804
255.3.5 Additional variables for <b>0-D</b> .....	805
255.3.6 Variables to impose in external boundary conditions BC3 BC4x BC5x and BC5XX .....	806
255.4 CCV imposed in an external RUPTURE element .....	807
255.5 CCVs imposed in a WALL .....	808
255.5.1 General variables .....	808
255.5.2 Variables for sensitivity parameter .....	809

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 19/851

255.6 CCVs imposed in an EXCHANGER .....	811
255.6.1 General variables.....	811
255.6.2 Variables for sensitivity parameter .....	811
255.7 CCVs imposed in a FUEL WALL .....	813
255.7.1 General variables.....	813
255.7.2 Variables for sensitivity parameters .....	814
255.7.3 Accessible variable after GOFUEL directive only for FUELCHAR elements .....	815
255.8 CCVs imposed in a reflooding sub-module (REFLCHAR/REFLCH3D) .....	817
255.9 CCVs imposed in an ACCUMULATOR .....	818
255.9.1 General variables.....	818
255.9.2 Variables for sensitivity parameters .....	818
255.10 CCVs imposed in a CANDLE .....	819
255.10.1 Variables for 1-D or 3-D element .....	819
255.10.2 Variables for 0-D element .....	819
255.11 CCVs imposed in a PIQxxx gadget .....	820
255.11.1 Variables for all PIQxxx gadgets .....	820
255.11.2 Additional variables for PIQBREK .....	820
255.11.3 Additional variables for PIQSOUP .....	821
255.11.4 Additional variables for PIQSEB .....	821
255.11.5 Additional variables for PIQVANNE .....	822
255.11.6 Additional variables for PIQREV .....	823
255.11.7 Additional variables for PIQARE .....	823
255.12 CCVs imposed in a 0D- PUMP .....	825
255.12.1 General variables .....	825
255.12.2 Variables for failure .....	825
255.12.3 Variables for sensitivity parameter .....	825
255.13 CCVs imposed in a SINK .....	826
255.13.1 General variables .....	826
255.13.2 Additional variables for a sink-safety valve .....	826
255.13.3 Additional variables for a RRI sink (type SINKRRI) .....	826
255.14 CCVs imposed in a SOURCE .....	828
255.14.1 General variables .....	828
255.14.2 Variables for sensitivity parameters .....	828
255.14.3 Additional variables for a SOURIS source .....	829
255.14.4 Variables for security injection characteristics .....	829
255.15 CCVs imposed in a 0D STEAM GENERATOR .....	830
255.16 CCVs imposed in a turbo-machine sub-module (TCOMCHAR) .....	831
255.17 CCVs imposed in a TURBINE .....	832
255.18 CCVs imposed in a CONTROL VALVE .....	833
255.19 CCVs imposed in a CHECK VALVE .....	834
255.20 CCVs imposed in a FLOW LIMITER .....	835
255.21 CCVs imposed in a neutronic sub-module (CORE) .....	836

 <small>DE LA RECHERCHE À L'INDUSTRIE</small>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 20/ <a href="#">851</a>

<a href="#">256 WRITHEAD DIRECTIVE</a>	<a href="#">837</a>
<a href="#">257 WRITVAR DIRECTIVE</a>	<a href="#">839</a>
<a href="#">258 XAXIS OPERATOR</a>	<a href="#">841</a>
<a href="#">259 XNEULIST AND XNEULISX DIRECTIVES</a>	<a href="#">842</a>
<a href="#">260 XRESLIST AND XRESLISX DIRECTIVES</a>	<a href="#">844</a>
<a href="#">261 ZONBAMOY DIRECTIVE</a>	<a href="#">846</a>
<a href="#">262 ZONE OPERATOR</a>	<a href="#">847</a>
<a href="#">BIBLIOGRAPHY</a>	<a href="#">848</a>
<a href="#">NOTATIONS</a>	<a href="#">849</a>
<a href="#">ACRONYMS</a>	<a href="#">850</a>
<a href="#">END OF DOCUMENT</a>	<a href="#">851</a>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 21/ <a href="#">851</a>

## DICTIONARY INDEX

### Symbols

#### 0-D (VOLUME) MODULE

CCFL .....	78, 754
GEOM .....	754
SINGULAR .....	258, 570, 754
SINGUMOD .....	754
VALBA FOR VOLUME .....	754
VALUE FOR VOLUME .....	754
VOLUME .....	171, 258, 307, 331, 334, 493, 508, 561, 611, 612, 617, 624, 751
WRITE FOR VOLUME .....	754

#### 1-D (AXIAL) MODULE

AXIAL .....	43, 66, 92, 101, 252, 293, 295, 303, 350, 483, 500, 512, 514, 561, 764, 769
CCFL .....	128, 137
GEOM .....	51, 295, 350
HYDR .....	51, 252, 350
HYDRCOM .....	51, 89, 303
HYDRMOD .....	89, 293
MESH .....	51, 252, 293, 295, 303
SCALAR .....	541, 747, 841
SEGMENT .....	350, 538, 747, 841
SINGULAR .....	51, 252, 295, 350, 569, 745
SINGUMOD .....	561
VALBA FOR AXIAL .....	51
VALUE FOR AXIAL .....	51
VECTOR .....	538, 541, 562, 841
WRIBA FOR AXIAL .....	51
WRITE FOR AXIAL .....	51
XAXIS .....	350, 538, 541, 562, 747

#### 3-D MODULE

BILAN3D .....	310, 327, 847
CCFL .....	79
CONNECT .....	266, 297, 351, 425, 565, 652
DTMASS3D .....	652
GEOM .....	102, 297, 351, 425, 565, 652
GODIFF .....	102, 282, 652
GOTURB .....	102, 276, 652, 666
HYDR .....	102, 266, 351, 425, 652

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 22/851

LOCATE3D .....	329, 351
MESH .....	102, 266, 297, 425, 565, 652
PHYSCALE .....	102, 266, 297, 351, 565, 652
PRIN3D .....	309, 327, 357, 413, 528, 653
SINGULAR .....	102, 266, 297, 351, 425, 652
THREED .....	59, 101, 102, 130, 266, 276, 282, 297, 351, 425, 483, 511, 561, 656, 666
TPERTR .....	102, 281, 415, 652
TURBULEN .....	102, 276, 282, 652
VALBA FOR THREED .....	652
VALUE FOR THREED .....	652
WRIBA FOR THREED .....	652

## A

### ACTIONS FOR SUB-MODULE

CLOSE .....	31, 33, 398, 401, 598
DISABLE .....	33, 62, 71, 78, 82, 116, 131, 134, 137, 177, 255, 431, 433, 435, 439, 443, 445, 554, 572, 576, 586, 587
ENABLE .....	33, 62, 70, 71, 78, 82, 116, 128, 131, 134, 177, 255, 431, 435, 439, 443, 445, 554, 572, 576, 586, 587
OPENALL .....	401, 572, 587
OPENBREAK .....	433, 554
OPEN .....	31, 33, 87, 598
STAROVRF .....	431, 620
STOPOVRF .....	431, 606
SWITCH .....	160, 162, 165

## B

### BOUNDARY CONDITION

ASSIGN .....	535
BCMOD .....	57, 359–361, 386, 506
BCCONDIT .....	53, 162, 331, 360
MODEL .....	53, 57, 386, 506
RUPTURE .....	43, 162, 516
VALBA FOR BC .....	57
VALBA FOR RG .....	535
VALUE FOR BC .....	57
VALUE FOR RG .....	535
WRIBA FOR BC .....	57
WRIBA FOR RG .....	535
WRITE FOR BC .....	57
WRITE FOR RG .....	535

## C

### CATAFUEL : Stand alone fuel calculation

CATAFUEL .....	90, 277, 288, 289, 291, 429, 487, 491, 522, 613, 626, 657
COMPHYD .....	75, 289, 291
HYDCHAN .....	75, 522, 626
HYDIMP .....	75, 90, 288, 291
HYDMOD .....	75, 90, 289
READHCAT .....	75, 90, 289, 291, 487, 613, 657
READHEXT .....	75, 90, 289, 291, 613, 657
RESHCAT .....	75, 288, 626
STDYFUEL .....	75, 90, 289, 291, 487, 491
STOREHYD .....	75, 76, 288, 289, 487, 522

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 23/851

TRANFUEL .....	75, 90, 289, 291, 389, 391, 487, 491
CIRCUIT, REACTOR	
CIRCUIT .....	49, 56, 179, 192, 321, 379, 386, 393, 479, 486, 767
INIBIL .....	59, 515, 847
MODGRAV .....	85
REACTOR .....	520, 525, 527, 536, 631, 667
REACTOR .....	85, 379, 386, 393, 429, 479
RESTEST .....	525, 527
RESTORE .....	170, 317, 332, 404, 485, 520, 523, 526, 527, 536, 631, 669, 749
SAVE .....	170, 309, 317, 327, 332, 357, 404, 413, 459, 523, 525–527, 631, 667, 669, 749
TOURNANT .....	89
USE .....	485
USE .....	525, 527
VALBA FOR CIRCUIT .....	85
VALUE FOR A CIRCUIT .....	85
VALUE FOR A REACTOR .....	486
WRITE FOR A REACTOR .....	486
ZONE .....	49, 56, 59, 192, 310, 321, 767
COMPUTATION OPTIONS	
FASTSIZE .....	317, 332, 404, 749
INISIM .....	170, 332, 404, 525, 749
MANAGE .....	170, 317, 404, 749
OPTION .....	170, 317, 332, 333, 412, 424, 461, 520, 657, 749
PERF .....	424, 461
PESEE .....	412, 461
PRINSTRU .....	412, 424
RESETIME .....	46, 170, 317, 332, 404, 528, 660, 749
VERBOSE .....	170, 317, 332, 404
<b>F</b>	
FLOWMIXER SUB-MODULE	
FLOMIXER ZOOM .....	493, 494
FLOMIXER .....	611, 617, 754
MANIFOLD .....	334
READMIX .....	173
STARTMIX .....	171, 173, 493, 611, 617
STOPMIX .....	171, 173, 611, 617
FLUID, NON CONDENSABLE GASES	
FLUID .....	85, 386
LOWPRESS .....	57
MONOPHAS(E) .....	53, 85, 179, 360, 415, 500
NONCOND .....	85, 479, 486
VALUEFLD .....	543, 670, 671, 686, 744, 792, 797
VALUFEAU .....	543, 670, 671, 683, 686
FUEL SUB-MODULE	
CLOSEGAP .....	194
FUELCHAR 41, 88, 119, 184, 202, 205, 272, 277, 279, 286, 287, 319, 382, 384, 409, 429, 449, 454, 455, 457, 511, 512, 514, 516, 533, 602–604, 614, 616, 625, 842, 844	194
FUELDTMX .....	194
FUELPLAQ .....	52, 165, 224, 295, 337, 384, 449, 455, 457, 618, 842, 844
FUEL3D .....	41, 119, 184, 194, 202, 205, 279, 319
FUEL .....	41, 119, 194, 202, 279, 319

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 24/851

GOFUEL .....	184, 194, 202, 205, 319
INTEGRATE .....	41, 184, 194, 205
MODXNEUT .....	194
MODXRES .....	194, 214, 844
PICTG .....	75, 194
PNRSHAPE .....	194, 214, 457, 756, 771
PNRSHAPX .....	194, 214, 457, 756, 771
POWER .....	66, 184, 194, 205, 214, 319
PRESHAPE .....	194, 214, 449
PRESHAPX .....	194, 214, 449
RELOC .....	516
RSETFUEL .....	194, 533, 616
STOPFUEL .....	194, 533
VALUE FOR FUELPLAQ .....	214
VALUE FOR 3D FUEL .....	184
VALUE FOR FUEL .....	194, 205
WRITE FOR FUELPLAQ .....	214
WRITE FOR 3D FUEL .....	184, 194
WRITE FOR FUEL .....	205
XRESLIST .....	194, 214, 384
XRESLISX .....	194, 214, 384
FUEL SUB-MODULE BALLOONING	
GOBALLON .....	194
FUEL SUB-MODULE, ACONDA MODEL	
HTCBACON .....	194, 614
STOPACON .....	194, 286
FUEL SUB-MODULE, OXIDATION	
OXRATE .....	194, 602–604
SPALLECR .....	409, 602, 604
SPALLOX .....	409, 602, 603
SPALL .....	409, 603, 604
FUEL SUB-MODULE, Yao-Hochreiter-Leech MODEL	
HTCBYHL .....	194, 625
STOPYHL .....	194, 287
<b>G</b>	
GROUP OF ELEMENTS	
AXIAL GROUP .....	49, 56, 192, 321, 767
BCONDIT GROUP .....	49, 56, 192, 321, 767
CONTROL ROD GROUP .....	114
FUELCHAR GROUP .....	49, 56, 192, 321, 767
JUNCTION GROUP .....	49, 56, 192, 321, 767
WALL GROUP .....	49, 56, 192, 321, 767
GUTHARE	
GUL_DAT .....	283, 390, 396
NEW_SYNT .....	283, 390, 396
OLD_SYNT .....	390, 396
<b>I</b>	
INPUT DECK	
BRUTEF77 .....	64
CHAR8 .....	129, 318

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 25/851

DOUBLE .....	81, 318, 631
END DATA .....	58
END EXEC .....	58
END .....	42, 136, 140, 304, 408, 477, 518
INTEGER .....	81, 129, 631
LAW .....	569, 570
MESSAGE .....	309, 327, 413, 459, 528, 653
OPENFILE .....	320, 489, 498, 530, 837, 839
QUIT .....	42, 136, 139, 140, 304, 408, 518
READHEAD .....	320, 403, 530, 837, 839
READVAR .....	320, 403, 489, 498, 530, 837, 839
REALIST .....	234, 323, 506
REPEAT .....	42, 136, 139, 140, 304, 408, 477, 518
REWIND .....	320, 403, 489, 498, 837, 839
TABLE .....	129, 317, 485, 525, 536
TITLE .....	309, 327, 357, 413, 459, 528
(MPa)UTILx .....	334, 543, 670, 671, 686, 792, 797
VALUE FOR USER .....	498
VALUE .....	671, 677, 683, 744, 792, 797
WRITE FOR USER .....	498
WRITE .....	44, 70, 671, 686, 751, 792
WRITHEAD .....	320, 403, 489, 498, 530, 839
WRITVAR .....	320, 403, 489, 498, 530, 837

## M

### MASS INJECTION OR EXTRACTION SUB-MODULE

ACCUMOD .....	33
ACCU .....	31, 87, 274, 311, 401, 479, 790, 792, 846
BREAK .....	128, 137, 162, 397
PIQARE .....	128, 137, 397, 606, 620
PIQBREK .....	62, 128, 160–162, 397, 398
PIQREV .....	128, 137, 160–162, 397
SGTR .....	398
SINKRRI .....	128, 137, 162, 397
SINK .....	128, 137, 162, 397, 664
SOURCEMOD .....	587
SOURCE .....	128, 137, 162, 397, 583
SOURIS .....	162, 397
VALBA FOR A BREAK .....	62
VALBA FOR A PIQxxx .....	431, 433, 435, 439, 443, 445
VALBA FOR A SGTR .....	554
VALBA FOR A SINK .....	572
VALBA FOR A SOURCE .....	587
VALUE FOR AN ACCU .....	33
VALUE FOR A SINK .....	572
VALUE FOR A SOURCE .....	587
VALUE FOR A BREAK .....	62
VALUE FOR A PIQxxx .....	431, 433, 435, 439, 443, 445
VALUE FOR A SGTR .....	554
WRIBA FOR A PIQxxx .....	431, 433, 435, 439, 443, 445
WRIBA FOR A SOURCE .....	587
WRITE FOR AN ACCU .....	33

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 26/851

WRITE FOR A SINK .....	572, 573
WRITE FOR A SOURCE .....	587
WRITE FOR A PIQxxx .....	431, 433, 435, 439, 443, 445
<b>MATHEMATICAL TOOLS</b>	
<b>ABSOLUTE</b> .....	127, 141, 164, 330, 388
<b>AND</b> .....	42, 127, 136, 139–141, 164, 184, 194, 205, 304, 319, 330, 339–349, 358, 388, 408, 477, 482, 518, 662
<b>DEGRE</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>ELSE</b> .....	42, 127, 139–141, 164, 304, 330, 339–349, 358, 388, 408, 477, 482, 518, 662
<b>ENDIF</b> .....	42, 127, 136, 139, 141, 164, 304, 330, 339–349, 358, 388, 408, 477, 482, 518, 662
<b>EXP</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>IF</b> .....	42, 127, 136, 139–141, 164, 330, 339–349, 358, 388, 408, 477, 482, 518, 662
<b>INTERP</b> .....	127, 141, 164, 330, 339–349, 358, 388, 403, 482, 489, 498, 530, 662, 839
<b>LOG</b> .....	164, 339–349, 358, 482, 662
<b>MATHEMATIC</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>MAX</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>MIN</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>NEQ</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>OR</b> .....	42, 127, 136, 139–141, 164, 304, 330, 339–349, 358, 388, 408, 477, 482, 518, 662
<b>RADIAN</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662
<b>TRIGONOMETRIC</b> .....	127, 141, 164, 330, 339–349, 358, 388, 482, 662

## N

### NEUTRONIC SUB-MODULE

<b>BYPASS</b> .....	51
<b>CONTROL ROD MECHA</b> .....	110
<b>CORE</b> .....	85, 110, 114, 279, 382, 393, 455, 479, 532, 540, 618
<b>GONEUT</b> .....	110, 114, 119, 532, 540, 618
<b>ROROD</b> .....	119, 279
<b>SCRAM</b> .....	37, 119, 274, 279, 311, 479, 790, 792, 846
<b>STOPNEUT</b> .....	119, 455
<b>VALUE FOR CORE</b> .....	119
<b>XNEULIST</b> .....	119, 194, 214, 279
<b>XNEULISX</b> .....	119, 194, 214, 279

## P

### PRINTOUTS

<b>IMPRIME</b> .....	327, 357, 413, 459, 528, 653
<b>LIST</b> .....	309, 357, 413, 459, 528, 653
<b>PERIOD</b> .....	309, 327, 357, 459, 528, 653
<b>RESULT</b> .....	309, 327, 357, 413, 459, 522, 653

### PUMP SUB-MODULE

<b>BLKROTOR</b> .....	411, 463, 473
<b>PCAVIT</b> .....	61, 463, 473
<b>POUNC</b> .....	463, 473
<b>PUMPCHAR</b> .....	61, 411, 452, 473, 476, 607, 621
<b>PUMPMOD</b> .....	61, 411, 463, 506, 607
<b>STARPUOMP</b> .....	61, 411, 463, 473, 621
<b>STOPPUMP</b> .....	61, 411, 463, 473, 607
<b>VALUE FOR PUMP</b> .....	463
<b>WRITE FOR PUMP</b> .....	463

### PUNCTUAL SG SUB-MODULE

<b>GVPOWER</b> .....	415, 550
----------------------	----------

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 27/851

SGCARACT .....	284, 552
SGFEED .....	284, 550
VALUE FOR SG CARACT .....	550
WRITE FOR SG CARACT .....	550

## R

### RADIO-CHEMICAL

ACTEMIS .....	274, 311, 479, 790, 792, 846
GOBORA .....	37, 311, 479, 790, 792, 846
INIBORA .....	37, 274, 479, 790, 792, 846
RADCHEMI .....	31, 33, 37, 85, 274, 311, 393, 486, 672, 790, 792, 846
VALBA .....	37, 274, 311, 479, 543, 670, 686, 689, 690, 790, 792, 797, 846
WCIRCB .....	37, 274, 311, 479, 792, 846
WRIBA .....	37, 274, 311, 479, 670, 671, 686, 790, 797, 846
ZONBAMOY .....	37, 274, 311, 479, 790, 792, 846

### REFLOODING SUB-MODULE

REFLCHAR .....	194, 511, 514
REFLCH3D .....	194, 514
REFLOOD .....	194, 511, 512
VALUE FOR REFLCHAR .....	511, 512
WRITE FOR REFLCHAR .....	511, 512

## S

### SPECIFIC SUB-MODULE

ASSIGN .....	92
COMPONENT .....	43, 51, 142, 771
EXHYLINK .....	576, 628
SENSOR .....	670, 671, 686, 792, 797
VALUE FOR SENSOR .....	543

### STEADY STATE

ECHPOWER .....	133, 142, 281, 305, 324, 392, 415
GOPERM .....	133, 165, 305, 307, 324, 392, 415, 528, 531
IMPOSFLOW .....	281, 307, 324, 392, 415
LEVEL .....	281, 305, 307, 392, 415, 508, 754
NOFLOW .....	281, 305, 307, 324, 415
PERMIT .....	49, 56, 133, 165, 192, 281, 305, 307, 321, 324, 386, 392, 500, 501, 503, 505, 508, 510, 515, 531, 656, 767
REALAX .....	281, 305, 324, 386, 392, 415, 515
REALC .....	56, 192, 281, 305, 307, 321, 324, 386, 392, 415, 503, 767
REALVO .....	281, 305, 324, 392, 415, 515
REINIT .....	500, 508
ROCPELEM .....	281, 415

## T

### TEE SUB-MODULE

CONNECT .....	255, 326, 651
GEOM .....	101, 651
SINGULAR .....	101, 255, 651
TEE .....	101, 128, 137, 255, 326, 561

### THERMAL SUB-MODULE

ADIABWAL .....	38, 181, 415, 756, 771
CANDLE .....	128, 137

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 28/851

EXCHANGER .....	43, 92, 158
EXCPOWER .....	142
EXWALINK .....	628, 771
FLUMOD .....	38, 756, 771
MATERIAL .....	214, 756, 771
POWER .....	38, 181, 506, 756, 771
RADIAT .....	38, 181, 771
STARTVC .....	624, 751
STOPVC .....	612, 751
VALUE FOR CANDLE .....	71
VALUE FOR EXCHANGER .....	142
VALUE FOR 3D WALL .....	756
VALUE FOR WALL .....	771
VFILM .....	612, 624, 754
WALLCOM .....	89, 769
WALLMOD .....	89, 764, 771
WALL3D .....	38, 40, 52, 181, 337, 449, 454, 483, 511, 514, 771
WALL .....	38, 40, 43, 52, 92, 165, 181, 284, 295, 337, 449, 454, 483, 506, 511, 512, 514, 550, 552, 756, 769
WRITE FOR CANDLE .....	71
WRITE FOR EXCHANGER .....	142
WRITE FOR 3D WALL .....	756
WRITE FOR WALL .....	771
TRANSIENT	
NEWDT .....	391, 658, 660
NEWTIME .....	389, 658, 660
TRANSENS .....	389, 391
TRANSIENT .....	389, 391
TURBINE SUB-MODULE	
MODPCST .....	381, 664
MODPNCST .....	380, 664
TURBINE .....	380, 381
VALUE FOR TURBINE .....	664
WRITE FOR TURBINE .....	664
TURBO-MACHINE SUB-MODULE	
SHAFTMOD .....	559, 609, 615, 622
SHAFT .....	557, 605, 609, 615, 622, 632
STARALTR .....	557, 559, 605, 609, 615, 622
STARSHAF .....	557, 559, 605, 609, 615, 622
STARSURG .....	610, 623, 632, 649
STOPALTR .....	557, 559, 605, 609, 615, 622
STOPSHAF .....	557, 559, 605, 609, 615, 622
STOPSURG .....	610, 632, 649
TCOMCHAR .....	559, 610, 623, 649
TCOMMOD .....	632
VALUE FOR TCOMCHAR .....	632
WRITE FOR TCOMCHAR .....	632
<b>V</b>	
VALVES SUB-MODULE	
CHECK VALVE .....	128, 137
CONTROL VALVE .....	128, 137
ECHECK .....	128, 137

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 29/ <a href="#">851</a>

ECVALVE .....	128, 137
FLOW LIMITER .....	128, 137
PIQSEB .....	128, 137, 397
PIQSOUPE .....	128, 137, 397
PIQVANNE .....	128, 137, 397
VALUE FOR VALVE .....	82, 116, 131, 134, 177
VALVE .....	561
WRITE FOR VALVE .....	82, 116, 131, 134, 177

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 30/ <a href="#">851</a>

## LIST OF FIGURES

31.2.1	CONNECT : A 3D cell . . . . .	105
48.1.1	EXCHANGER : Explicit exchanger between two circuits . . . . .	144
52.0.1	EXWALINK : Scheme modeling . . . . .	166
52.0.2	EXWALINK : model . . . . .	167
56.0.1	FLOW LIMITER : configuration . . . . .	178
65.2.1	GEOM for TEE : Front sectional view . . . . .	256
65.2.2	GEOM for TEE : side view . . . . .	257
65.3.1	GEOM for Volume : geometry configuration for inclined junctions . . . . .	262
133.0.1	PERMINIT : Example 3: One DEADZONE for accumulator . . . . .	419
133.0.2	PERMINIT : Example 4: Two DEADZONE for accumulator . . . . .	420
133.0.3	PERMINIT : Example 6 for SG . . . . .	422
149.0.1	PUMPCHAR : operating octants . . . . .	463
195.1.1	SINKRRI : modeling scheme for the 1 <sup>st</sup> case . . . . .	582
195.2.1	SINKRRI : modeling scheme for the 2 <sup>nd</sup> case . . . . .	582
241.18.1	VALUE : SWLLEVEL Sensor for the measure of the swell level . . . . .	731

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 31/ <a href="#">851</a>

1

## ACCUMOD DIRECTIVE

This directive is used to modify laws of an accumulator **before its opening** or if the accumulator is **closed and not empty**, in *command block*.

### Associated Keywords

**ACCU, OPEN, CLOSE, RADCHEMI**

### Syntax

<b>ACCUMOD</b>	accuname		
		<b>LIQUID</b>	
			<b>HL</b> or <b>TL</b>
			or, and
			or, and
		<b>SPECIF</b>	<b>INIP</b>
			xhl or xt1
			<b>LIQVOL</b>
			xinip
			xliqvol
	or, and		
		<b>EXPANSIO</b>	xexpansio
		<b>COEF</b>	xcoef
	or, and	<b>BORON</b>	xbormasfr
	or, and	<b>NONCOND</b>	xnitmasfr
		<b>NITMASFR</b>	

accuname : name of the accumulator.

**LIQUID** : keyword to indicate that the specifications of the liquid in the accumulator are going to be changed, followed by :

**HL** xhl : keyword followed by a real number > 0 which re-defines the initial enthalpy of water (J/kg) in the accumulator

**or TL** xt1 : keyword followed by a real number > 0 which re-defines the initial temperature of water (°C) in the accumulator

**or INIP** xinip : keyword followed by a real number > 0 which re-defines the initial pressure of water (Pa) in the accumulator

**or LIQVOL** xliqvol : keyword followed by a real number > 0 which re-defines the initial volume of water (m<sup>3</sup>) in the accumulator

**or SPECIF** : keyword to indicate that the specifications of the accumulator are going to be changed, followed by :

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 32/851

<b>EXPANSIO</b> xexpansio	: keyword followed by a real number > 0 which re-defines the gas expansion coefficient.
<b>or COEF</b> xcoef	: keyword followed by a real number > 0 which re-defines the head loss coefficient.
<b>or BORON</b>	: keyword to indicate that the specifications of the boron in the accumulator are going to be changed, followed by :
<b>BORMASFR</b> xbormasfr	: keyword followed by a real number > 0 which re-defines the BORON concentration in the water of the accumulator (in kg of boron/kg of liquid).
<b>or NONCOND</b>	: keyword to indicate that the specifications of the non-condensable gas declared in the ACCU operator are going to be changed. This keyword is followed by :
<b>NITMASFR</b> xnitmasfr	: keyword followed by a real number > 0 which re-defines the mass fraction of non-condensable gas diluted in the water of the accumulator.

**NB :**

1. If only the HL keyword is used, the equilibrium temperature of gas and water in the accumulator will be re-calculated at HL and the initial pressure given in the ACCU operator of the data block :  $T_G = T_L = T_L(H_L, P_{ini})$ ,
2. If only the INIP keyword is used, equilibrium temperature of gas and water in the accumulator will be re-calculated at INIP and the initial liquid enthalpy in the accumulator given in the ACCU operator of the data block :  $T_G = T_L = T_L(H_{Lini}, P)$ ,
3. If only the TL keyword is used, the equilibrium temperature of gas and water in the accumulator is set to TL, the enthalpy of water in the accumulator will be re-calculated using TL and at the initial pressure in the accumulator given with ACCU operator of the data block :  $T_G = T_L$  and  $H_G = H_L(T_L, P_{ini})$

**WARNING :** It is forbidden to change  $T_L$  and  $H_L$ .

Example
---------

ACCUMOD	ACCUM	LIQUID	
HL	213.D3	INIP	41.87D5
SPECIF			
EXPANSIO	1.2	COEF	6.023D0
BORON	BORMASFR	7.3D-4	
NONCOND	NITMASFR	7.2D-4 ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 33/851

2

## ACCU OPERATOR

The **ACCU** operator creates an accumulator on the basis of a point model. This operator must be used in *data block*. An accumulator can be defined on an **AXIAL** or **VOLUME** element.

**NB :** ACCUMULATOR is automatically opened with pressure condition. It can be disconnected (see CLOSE directive) and then connected again (see OPEN directive).

### Associated Keywords

OPEN, CLOSE, ENABLE, DISABLE(VALVE model), ACCUMOD, RADCHEMI, VALUE FOR AN ACCU, WRITE FOR AN ACCU

### Syntax

## 2.1 ACCU on an AXIAL element

accum =	<b>ACCU</b>	elemtype	elem	
	<b>(EXPLICIT)</b>	ip	<b>TOTV</b>	z1
	<b>INIV</b>	z2	<b>ELEV</b>	z3
	<b>SECT</b>	z4	<b>LONGLINE</b>	z5
	<b>COEF</b>	z6	<b>ANGLE</b>	z7
	<b>INIP</b>	z8	<b>HL</b>	z9
	<b>(ALTI</b>	<b>SECT</b>	z10	<b>ELEV</b>
	<b>(EXPANSIO</b>	z12)	<b>(NOCLOSE)</b>	z11)
	<b>(NONCOND</b>	z14)	<b>(NITMASFR</b>	z15)
	<b>(BORMASFR</b>	z16)	<b>(VALVE</b>	A
	<b>(NOADIAB )</b>	;		B)

## 2.2 ACCU on a VOLUME element

accum =	<b>ACCU</b>	elemtype	elem	
	<b>(EXPLICIT)</b>		<b>TOTV</b>	z1
	<b>INIV</b>	z2	<b>ELEV</b>	z3
	<b>SECT</b>	z4	<b>LONGLINE</b>	z5

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 34/ <a href="#">851</a>

<b>COEF</b>	z6	<b>LENGTH</b>	z7	
<b>INIP</b>	z8	<b>HL</b>	z9	
<b>(ALTI</b>	<b>SECT</b>	z10	<b>ELEV</b>	z11)
<b>(EXPANSIO</b>	z12)	<b>(NOCLOSE)</b>		
<b>(NONCOND</b>	z14)	<b>(NITMASFR</b>	z15)	
<b>(BORMASFR</b>	z16)	<b>(VALVE</b>	A	B)

;

- accum** : name of the accumulator.
- elemtype** : type of the element : AXIAL or VOLUME.
- elem** : element on which the accumulator is defined
- ip** : case of an AXIAL element : axial scalar mesh number on which the accumulator is connected.
- EXPLICIT** : OPTIONAL keyword. If given, the accumulator will be explicit (default is implicit).
- TOTV z1** : keyword followed by a real number  $> 0$  which defines the total volume of the accumulator ( $m^3$ ).
- INIV z2** : keyword followed by a real number  $> 0$  which defines the initial volume of water ( $m^3$ ).
- ELEV z3** : keyword followed by a real number.  
For an AXIAL element, this number defines the position of the injection point with respect to the bottom of the pipe. It must be  $\geq 0$  and  $\leq 1$  since it is expressed as a fraction of hydraulic diameter.  
Example :  
ELEV 0. Injection at the bottom of the pipe and ELEV 1. Injection at the top of the pipe  
ELEV 0.5 Lateral injection half way up the pipe.  
For a VOLUME element, this number defines the elevation (m) of the injection point with respect to the bottom of the volume and must be  $\geq 0$  and  $<$  height of the volume.
- SECT z4** : keyword followed by a real number  $> 0$  which defines the cross-section of the discharge line ( $m^2$ ).
- LONGLINE z5** : keyword followed by real number  $\geq 0$  which defines the length of the discharge line (m).
- COEF z6** : keyword followed by a real number  $\geq 0$  which defines the head loss coefficient.
- ANGLE z7** : case of an AXIAL element : keyword followed by a real number which defines the angle between the discharge line and the mesh direction of the axial (rad). This value should not be mentioned for an accumulator in a VOLUME element.
- LENGTH z7** : case of a VOLUME element : keyword followed by a real number which defines the penetration length of the discharge line into the VOLUME element (m). This value should not be mentioned for an accumulator in an AXIAL element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 35/ <a href="#">851</a>

<b>INIP z8</b>	: keyword followed by a real number $> 0$ which defines the initial pressure (Pa) in the accumulator.
<b>HL z9</b>	: keyword followed by a real number $> 0$ which defines the initial enthalpy of water (J/kg) in the accumulator.
<b>ALTI</b>	: OPTIONAL keyword which can be used to take into account the position and the shape of the accumulator (used to modify the gravity value in calculation). If it is used it must be followed by :
<b>SECT z10</b>	: keyword followed by a real number $> 0$ which defines the cross-section of the accumulator ( $\text{m}^2$ ).
<b>ELEV z11</b>	: keyword followed by a real number which defines the elevation of the accumulator (m), above or below the injection point. This is the difference between the injection point axis and the bottom of the accumulator; it is positive when the accumulator is below the injection point.
<b>EXPANSIO z12</b>	: OPTIONAL keyword. If used, it is followed by a real number $> 0$ which defines the gas expansion coefficient. The default value for gas expansion is 1.4 (value for dynamic ideal gas).
<b>NOCLOSE</b>	: OPTIONAL keyword. If given, after total evacuation of water, non-condensable gas will be discharged. This gas must have been declared in the circuit with the NONCOND directive. The default gas is NITROGEN.
<b>NONCOND z14</b>	: OPTIONAL keyword followed by the name of a non-condensable gas different than NITROGEN. This other gas must have been declared in the circuit.
<b>NOADIAB</b>	: OPTIONAL keyword. If used, the accumulator gaseous propellant exchanges heat with the structures and with the liquid free surface between the accumulator discharges.
<b>NITMASFR z15</b>	: OPTIONAL keyword followed by a real number $\geq 0$ and $\leq 1$ , defining the mass fraction of non-condensable gas diluted in the water of the accumulator. This gas must have been declared in the circuit. The default value is 0.
<b>BORMASFR z16</b>	: OPTIONAL keyword followed by the BORON concentration in the water of the accumulator (in kg of boron/kg of liquid). BORON must have been declared in the circuit. The default value is 0.  Remarks: If an accumulator containing diluted BORON is opened during a calculation without BORON there is no error message. BORON of the accumulator is merely not taken into account.
<b>VALVE A B</b>	: OPTIONAL keyword followed by two real numbers. These two numbers are coefficients used to add an additional head loss to the calculation of $\Delta P_{\text{acc}}$ . This head loss is calculated as followed : $A + B \cdot Q_{G_{\text{acc}}}^2$ (homogeneous to a pressure in Pa).

### Example

ip = SCALAR cold1 2.D0 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 36/ <a href="#">851</a>

```

accul =    ACCU      AXIAL     cold1      ip          ELEV      1.D0
           TOTV      41.06D0   INIV       27.75D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   ANGLE      1.57D0
           INIP      41.87D5   HL         213.D3 ;

accu2 =    ACCU      AXIAL     cold1      ip          ELEV      0.5D0
           TOTV      41.06D0   INIV       27.75D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   ANGLE      1.57D0
           INIP      41.87D5   HL         213.D3
           ALTI      SECT      5.5864D-2  ELEV      1.3D0
           NOCLOSE   NITMASFR 0.05D0 ;

accu3 =    ACCU      AXIAL     cold1      ip          ELEV      0.5D0
           TOTV      41.06D0   INIV       27.75D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   ANGLE      1.57D0
           INIP      41.87D5   HL         213.D3
           ALTI      SECT      5.5864D-2  ELEV      1.3D0
           NOCLOSE   NONCOND   HELIUM
           NITMASFR 0.05D0 ;

accu4 =    ACCU      AXIAL     cold1      ip          ELEV      0.D0
           TOTV      41.06D0   INIV       27.75D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   ANGLE      1.57D0
           INIP      41.87D5   HL         213.D3
           ALTI      SECT      5.5864D-2  ELEV      1.3D0
           EXPANSION 1.8D0    VALVE     1.0D5      20.0D0 ;

accu5 =    ACCU      AXIAL     cold1      ip          ELEV      0.D0
           TOTV      41.06D0   INIV       27.75D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   ANGLE      1.57D0
           INIP      41.87D5   HL         213.D3
           ALTI      SECT      5.5864D-2  ELEV      1.3D0
           EXPANSION 1.8D0    NOCLOSE   BORMASFR 0.01D0 ;

accu6 =    ACCU      VOLUME    volvol
           TOTV      41.06D0   INIV       27.75D0   ELEV      0.5D0
           SECT      5.5864D-2  LONGLINE  26.7D0
           COEF      6.023D0   LENGTH     0.2D0      INIP      41.87D5
           HL        213.D3    VALVE     1.0D5      20.0D0 ;

```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 37/851

3

## ACTEMIS DIRECTIVE

The **ACTEMIS** directive is used in the command block to trigger the **ACTIVITY** emission by the core in emergency shutdown when the scram directive is not used.

If the **SCRAM** directive is used (case of neutronics calculation), it automatically triggers the **ACTIVITY** emission by the core in emergency shutdown.

### Associated Keywords

**SCRAM, WRIBA, VALBA, RADCHEMI, WCIRCB, INIBORA, GOBORA, ZONBAMOY**

### Syntax

**ACTEMIS**      circ;

**circ**                : name of the circuit including the core element

### Example

**ACTEMIS**      circ1;

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 38/851

# 4

## ADIABWAL DIRECTIVE

The **ADIABWAL** directive is used in the *command block* to enable or disable heat exchanges with the outside environment (defined by keyword LOSS of operator WALL and FUELPLAQ) for one or several walls. It can be used just before the steady state (directive GOPERM) or at any time of the transient calculation. By default, heat exchanges of a wall with the outside or through exchanger walls environment are enabled.

### Associated Keywords

**WALL, WALL3D, FLUMOD, ADIABWAL, POWER, RADIAT**

### Syntax

```
ADIABWAL      circ1          (RESTORE)    wall1           wall2 ...       walln        ;  
or  
ADIABWAL      circ1          (RESTORE)    ALL           ;
```

<b>circ1</b>	: circuit name
<b>RESTORE</b>	: OPTIONAL keyword that indicates the heat exchanges with the outside will be enabled for all specified walls. <u>If it is not used those exchanges will remain disabled.</u>
<b>wall1, wall2 ... walln</b>	: list of walls defined on elements of the circuit circ1.
<b>ALL</b>	: keyword that indicates all the heat exchanges, in circuit circ1, between walls and the outside will be enabled or disabled. <b>BEWARE that it includes also exchanger walls</b>

### Example

```
1)  
ADIABWAL      CIRC1      wall2      wall3      wall4 ;  
GOPERM          ;  
2)  
ADIABWAL      CIRC1      RESTORE   ALL ;  
GOPERM          ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 39/ <a href="#">851</a>

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is ADIABWAL. The argument are the following ones :  
CALL ADIABWAL ( OBJNAM, CVAL, NVAL, \*9999)

OBJNAM	name of the circuit (character*8)
CVAL	array of NVAL 8*character strings containing the other arguments of the directive ADIABWAL (example : CVAL(1) = 'RESTORE ', CVAL(2) = 'ALL ')
NVAL	length of array CVAL (integer)

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 40/ <a href="#">851</a>

5

## ALWMIN DIRECTIVE

The **ALWMIN** directive allows the user to modify the dry out criterion used in the wall to fluid heat transfer calculation (the default value is 0.99999). It is used in the *executive block*.

### Associated Keywords

**WALL**, **WALL3D**

### Syntax

**ALWMIN**      xval      elem      ;

xval      : new dry out criterion  
 elem      : name of a wall, an element, a circuit or a reactor

### Example

**ALWMIN**      0.9D0      CIRCTOT ;

**N.B** : the FORTRAN subroutine called in PILOT is ALWMIN : CALL ALWMIN (AGMINI, OBJNAM, \*9999)

AGMINI      DOUBLE PRECISION new dry out criterion  
 OBJNAM      CHARACTER\*8 name of the element

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 41/851

# 6

## AND OPERATOR

The **AND** operator can be used in *data block* or in *command block*.

### 6.1 Case of fuel

The **AND** operator is allowed, in *data block*, only for linking the elementary fuels (1D or 3D type) defined on the same element. The fuels cannot have any common axial meshes.

#### Elementary FUEL3D objects type

In the case of elementary FUEL3D objects type, the linked object can be obtained by using two different ways :

1. The direct mode : The linked object is created using the existing elementary FUEL3D objects type.
2. The copy mode : The linked object is created using virtual elementary FUEL3D objects type. They are obtained by a copy of existing elementary FUEL3D objects type. In that case, one has to give the scalar coordinates of the first elementary FUEL3D object to be copied.

#### Elementary FUEL objects type

In the case of 1D elementary fuels, only the direct mode is available.

#### Associated Keywords

FUEL, FUELCHAR, FUEL3D, INTEGRATE

#### Syntax

**object3 = (COPY i j k) object1 AND object2 ... AND objectn ;**

**object3** : Linked fuel object

**COPY** : OPTIONAL keyword to be used only for elementary FUEL3D objects type.

**i j k** : 3 integers corresponding to the scalar coordinates of the first elementary FUEL3D object  
“object1” to be copied (i = Z layer (axial), j = Θ sector (azimuthal), k = R layer(radial)).

**object1** : n elementary FUEL3D objects

**object2 ...**

**objectn**

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 42/851

### Example

Assuming that COMR1A0i {i = 1,10} are created elementary FUEL3D objects type.

```

COMBUR1A =      COMR1A01      AND COMR1A02      AND COMR1A03      AND
                COMR1A04      AND COMR1A05      AND COMR1A06      AND
                COMR1A07      AND COMR1A08      AND COMR1A09      AND
                COMR1A10      ;          

COMBUR1B =      COPY 2 1 5    AND COMR1A02      AND COMR1A03      AND
                COMR1A01      AND COMR1A05      AND COMR1A06      AND
                COMR1A04      AND COMR1A08      AND COMR1A09      AND
                COMR1A07      ;          

COMBUR1C =      COPY 3 1 5    AND COMR1A02      AND COMR1A03      AND
                COMR1A01      AND COMR1A05      AND COMR1A06      AND
                COMR1A04      AND COMR1A08      AND COMR1A09      AND
                COMR1A07      ;          

                COMR1A10      ;
  
```

## 6.2 Case of logical

The **AND** operator is allowed in *command block* as a logical symbol in conditional expressions.

### Associated Keywords

REPEAT, END, IF, ENDIF, ELSE, QUIT, AND, OR

### Syntax

```

IF      ( TIME > 150.0 AND IGO > 1 );
      QUIT BLOC1 ;
ENDIF  ;

IF      ( P > 70.D5 AND ICO EQ 0 );
      ... ;
ENDIF  ;
  
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 43/851

7

## ASSIGN DIRECTIVE

The **ASSIGN** directive may only be used :

1. to assign characteristics to a rupture object in *data block* or *command block*,
2. to assign COMPONEN(T) characteristics to an AXIAL type object in *data block*, including some of its thermal WALL structures and FUELCHAR/FUELPLAQ structures.

### Associated Keywords

**RUPTURE, COMPONEN, AXIAL, EXCHANGER, WALL**

## 7.1 ASSIGN directive for a Rupture

### Syntax

#### 7.1.1 For an internal rupture : outside data are given through laws function of time

**In data block :**

```

ASSIGN ruptur1
      LAW      STDCP1
      or
      law1      FULOPN    tfulopn      PFULOPN    pfulopn
                 (NONCOND lawx1      (lawx2)
                  (lawx3)      (lawx4) )
                 (TEMPGAS law2 )
                 ABSTIME   tedec       ;

```

**ruptur1** : rupture object.

**LAW** : keyword to indicate that a law for the specification of pressure in the containment building will be defined.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 44/851

There are two possible ways of defining this law for a double ended break :

<b>STDCP1</b>	: keyword to indicate that the user wants to use the standard built-in law for pressure in the containment building (for a CP1-type reactor), defined in the library.
<b>or</b>	
<b>law1</b>	: law entered by the user, corresponding to the pressure variation law as a function of relative time (related to the onset of the rupture).
<b>FULOPN tfulopn</b>	: keyword followed by a real number $\geq 0$ . which defines the relative time (related to the onset to the rupture) at which the double ended break reaches its maximum opening (in seconds).
<b>PFULOPN pfulopn</b>	: keyword followed by a real number $\geq 0$ . which defines the pressure (Pa) outside the rupture at the time at which the double ended break reaches its maximum opening
<b>NONCOND</b>	: OPTIONAL keyword to indicate that the user is defining a law (or several laws) for the non-condensable gas mass fractions in the containment building. This keyword <b>must</b> be used if one (or more) non-condensable gases are defined in the circuit (by the NONCOND operator).
<b>lawx1</b>	: law defining the mass fraction for the first non-condensable gas as function of time.
<b>lawx2</b>	: similar to lawx1 but for the 2nd non-condensable gas.
<b>lawx3</b>	: similar to lawx1 but for the 3rd non-condensable gas.
<b>lawx4</b>	: similar to lawx1 but for the 4th non-condensable gas.
<b>TEMPGAS</b>	: OPTIONAL keyword to indicate that the user is defining a law for the gas temperature in the containment building.
<b>law2</b>	: law defining the gas temperature as a function of relative time ( $^{\circ}\text{C}$ ) (related to the onset of the rupture).
<b>ABSTIME tedec</b>	: keyword followed by a real number $\geq 0$ . which defines the time at which the double ended break opens (in seconds).

### 7.1.2 For an external rupture : in this case user can access to imposed values through CCV

(see **WRITE** for an external rupture element)

In data block :

```

ASSIGN      ruptur1
EXTERNAL
  TOPEN      tpen
  POPEN      ppen
  FULOPN    tfulopn
  PFULOPN   pfulopn
  (X1EXT    x1           X2EXT    x2
  X3EXT    x3           X4EXT    x4 )
  (TGASEXT  tge)
  ABSTIME   tedec       ;

```

**ruptur1** : rupture object.  
**EXTERNAL** : keyword to indicate that the values are given by CCV.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 45/ <a href="#">851</a>

The parameters **topen**, **popen**, **tfulopn** and **pfulopn** allow to ensure a smoothed opening of the rupture.

<b>TOPEN topen</b>	: keyword followed by a real number $\geq 0$ . which defines the relative time (related to the onset of the rupture) at which the double ended break is partially open (in seconds).
<b>POPN popen</b>	: keyword followed by a real number $\geq 0$ . which defines the pressure (Pa) outside the rupture at the <u>time topen</u> .
<b>FULOPN tfulopn</b>	: keyword followed by a real number $\geq 0$ . which defines the relative time (related to the onset of the rupture) at which the double ended break reaches its maximum opening (in seconds).
<b>PFULOPN pfulopn</b>	: keyword followed by a real number $\geq 0$ . which defines the pressure (Pa) outside the rupture at time at which the double ended break reaches its maximum opening.
<b>X1EXT x1</b>	: OPTIONAL keyword followed by the external mass concentration of the 1 <sup>st</sup> non-condensable in the containment building (optional).
<b>X1EXT x2</b>	: OPTIONAL keyword followed by the external mass concentration of the 2 <sup>nd</sup> non-condensable in the containment building (optional).
<b>X1EXT x3</b>	: OPTIONAL keyword followed by the external mass concentration of the 3 <sup>rd</sup> non-condensable in the containment building (optional).
<b>X1EXT x4</b>	: OPTIONAL keyword followed by the external mass concentration of the 4 <sup>th</sup> non-condensable in the containment building (optional).
<b>TGASEXT tge</b>	: OPTIONAL keyword followed by the gas temperature ( $^{\circ}\text{C}$ ) in the containment building.
<b>ABSTIME tedec</b>	: keyword followed by a real number $\geq 0$ . which defines the instant the double ended break opens (in seconds).

The external pressure  $P_{ext}$  which defines the pressure outside the rupture must have to be set by [CCV](#) in the executable block, before the opening.

The time  $tfulopn$  shoud be greater than  $topen$ . In case of a fulopn smaller than  $topen$ , the data fulopn and pfulopn are not taken into account.

For time smaller than  $tfulopn$  (or  $topen$ ), the pressure ouside the rupture is calculated using linear interpolations between the  $tedec$ ,  $topen$  and  $tfulopn$  times and the associated input pressures  $popen$  and  $pfulopn$ .

For time greater than  $tfulopn$  (or  $topen$ ), the external pressure  $P_{ext}$  is used.

The values of the external  $P_{ext}$  Pext [CCV](#), the  $popen$  and the  $pfulopn$  pressures have to be consistent with a break opening.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 46/ <a href="#">851</a>

### Command bloc directive

It can be used additionally to the preceding ones, for example to change the time of break opening after a **RESETIME** directive.

#### Syntax

```
ASSIGN      ruptur1      ABSTIME      tedec ;
```

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is RGMODTIM. The argument are the following ones : CALL RGMODTIM (OBJNAM, TIMERG, \*9999)

OBJNAM	name of the rupture (character*8)
TIMERG	Real number equal to the time of break opening

#### Example

##### 1. In data block

```
1)  
ASSIGN      ruptu      LAW      STDCP1      ABSTIME      t1      ;
```

```
2)  
law1 =      LAW      'TIME'      'PRESSURE'  
           0.          1.0D5  
           10.         3.0D5  
           300.        .5D5      ;
```

```
lawx =      LAW      'TIME'      'CONCENTRATION'  
           0.          0.0  
           10.         0.5      ;
```

```
Law3 =      LAW      'TIME'      'TEMPERATURE'  
           0.          0.0  
           10.         27.      ;
```

```
ASSIGN      rup      LAW      Law1  
           FULOPN    t1      PFULOPN   p1  
           ABSTIME    t0      ;
```

or

```
ASSIGN      rup      LAW      Law1  
           FULOPN    t1      PFULOPN   p1  
           NONCOND   lawx     ABSTIME    t0      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 47/851

or

```

ASSIGN    rup      LAW      Law1
          FULOPN t1  PFULOPN
                      p1
          NONCOND   lawx
          TEMPGAS   Law3      ABSTIME   t0      ;
3)
ASSIGN    rup      EXTERNAL
          TOPEN    .003D0
          POPEN    0.97D5
          FULOPN   3.D-3
          PFULOPN 0.97D5
          X1EXT    1.D-5     X2EXT    0.99
          TGASEXT 80.D0     ABSTIME   1.D-08  ;

```

2. In command block

```
4) ASSIGN    ruptu    ABSTIME   t0      ;
```

## 7.2 ASSIGN directive for an AXIAL

### Data block directive only

#### Syntax

```

ASSIGN    component_name
          axial_name   ( z1 z2 )
          (FRICTION) (EXCHANGE  wall_name_1   ... wall_name_n
                         )           ;
or        (FRICTION) (EXCHANGE  fuel_name_1   ... fuel_name_n
                         )           ;
or        (FRICTION) (EXCHANGE  exch_name_1  ... exch_name_n
          PRIMARY    SECONDARY)           ;

```

component_name	: COMPONEN(T) type object to be applied.
axial_name	: AXIAL type object to which characteristics are applied.
z1	: OPTIONAL real number $\geq 0$ giving the elevation of the first point of the axial where characteristics are applied.
z2	: OPTIONAL real number $\geq 0$ giving the elevation of the last point of the axial where characteristics are applied.

By default the characteristics are applied to the whole axial element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 48/ <a href="#">851</a>

It is followed by the type of relationship to be used by the AXIAL element (at least one keyword must be used) :

<b>FRICITION</b>	: keyword to indicate that the user wants to use the modified relationship for wall friction coefficient computation using the data of the assigned COMPONENT object (component_name).
<b>EXCHANGE</b>	: keyword to indicate that the user wants to use the modified relationship applied for the computation of the convective heat transfer coefficient using the data of the assigned COMPONENT. It is followed by the name of the thermal structure to which the modified correlation must be applied.
wall_name_1 ... wall_name_n	: name of the thermal structures in case of a simple WALL.
Or	
fuel_name_1 ... fuel_name_n ...	: name of FUELCHAR or FUELPLAQ object.
Or	
exch_name_1 ... exch_name_n	: name of the thermal structures in case of a exchanger.
<b>PRIMARY</b>	: keyword to indicate the primary side of the exchanger.
Or	
<b>SECONDARY</b>	: keyword to indicate the secondary side of the exchanger.

### Example

1. For a simple wall

```
ASSIGN COEURPLA PIPE1 FRICITION ;
ASSIGN COEURPLA PIPE1 0. 3.25 FRICITION EXCHANGE PAROI1 PAROI2 PAROI3;
```

2. For a exchanger wall primary side

```
ASSIGN HELICRCF PIPE1 EXCHANGE PAROI1 PRIMARY ;
```

3. For a exchanger wall secondary side

```
ASSIGN HELICRCF IPIPE1 EXCHANGE PAROI1 SECONDARY ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 49/ <a href="#">851</a>

8

## AXIAL GROUP OPERATOR

The **AXIAL GROUP** operator creates an AXIAL element of type **GROUP** in the *data block*. This operator must be coupled at least with the use of the **JUNCTION GROUP**, **BCONDIT GROUP** and **ZONE** operators.

### Associated Keywords

**JUNCTION GROUP**, **AXIAL GROUP**, **WALL GROUP**, **FUELCHAR GROUP**, **BCONDIT GROUP**, **ZONE**, **CIRCUIT**, **PERMINIT**

### Syntax

```
axna1 = AXIAL      GROUP      TEMPLATE
          axna2       junc1      sens1      junc2      sens2 ;
```

<b>axna1</b> <b>GROUP</b> <b>TEMPLATE</b> <b>axna2</b>	: name of the <b>AXIAL GROUP</b> element. It must not exceed 5 characters. : keywords followed by the name of an axial element already existing in the data bloc. This operator will duplicate the characteristics of the axna2 element for the axna1 element, as many time as defined in the <b>JUNCTION GROUP</b> junc1 and junc2.
<b>junci sensi (i=1,2)</b>	: name of the <b>JUNCTION GROUP</b> followed by a keyword which defines the orientation of the junction in the element. This keyword is either <b>USTREAM</b> or <b>DSTREAM</b> .

### Example

The AXIAL element to copy must be declared first in the data bloc as well as the JUNCTION GROUP objects connected to the AXIAL GROUP element.

```
bota = JUNCTION GROUP
          157    SUFFIX     1        WEIGHT   CONST      264      ;
topa = JUNCTION GROUP
          157    SUFFIX     1        WEIGHT   CONST      264      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 50/ <a href="#">851</a>

meancore =      **AXIAL**      lowmean      **USTREAM**      uppmean      **DSTREAM**  
                 **WEIGHT**      41448      ;

Then the AXIAL GROUP cana can be defined. Cana will contain 157 identical axial elements called cana001 to cana157.

cana =      **AXIAL**      **GROUP**      **TEMPLATE**      meancore      bota  
                 **USTREAM**      topa      **DSTREAM**      ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 51/851

9

## AXIAL OPERATOR

The **AXIAL** operator creates an axial element in the *data block*.

### Associated Keywords

GEOM, HYDR, HYDRCOM, MESH, SINGULAR, COMPONEN, VALBA FOR AXIAL, WRIBA FOR AXIAL, VALUE FOR AXIAL, WRITE FOR AXIAL, BYPASS

### Syntax

```
elem =    AXIAL junc1    sens1    junc2    sens2    WEIGHT ip      ;
```

**elem** : axial element.

**junc1 sens1** : junction followed by a keyword which defines the orientation of the junction in the element. This keyword is **USTREAM** or **DSTREAM**.

**Warning:** Check that for the other element related to this junction, the other keyword is used.

**WEIGHT ip** : OPTIONAL keyword followed by a positive integer which defines the weight of the element. The default weight of the element is 1.

**Definition :** The weight of an element is the number of identical elements simulated by this element. The weight of elements is used in mass and energy balances

### Example

```
meancore =    AXIAL      lawmean      USTREAM      uppmean      DSTREAM
              WEIGHT      41448      ;
```

```
downco =      AXIAL      downdown    USTREAM      downfond      DSTREAM      ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 52/851

# 10

## AXICOND DIRECTIVE

*Command block only.*

This directive must be used to activate or deactivate the axial conduction computation within a WALL (1D or 3D) or a FUELPLAQ. At least, the activation have to be enabled after the steady state.

### Associated Keywords

**WALL, WALL3D, FUELPLAQ**

## 10.1 Activation of the AXICOND directive

### Syntax

**AXICOND      wall1            ON;**

wall1            : wall name

## 10.2 Deactivation of the AXICOND directive

### Syntax

**AXICOND      wall1            OFF ;**

wall1            : wall name

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 53/851

# 11

## BCMOD DIRECTIVE

The **BCMOD** directive is used to modify a boundary condition (BCONDIT) during a transient, in *command block*.

The types of available boundary conditions are as follows (see operator MODEL) :

1. BLIND (internal type)
2. User-managed conditions :
  - (a) Internal type (the variables are defined in laws with respect to time) :
    - i. BC3A, BC3B ... BC3H,
    - ii. BC4A, BC4B, BC4C,
    - iii. BC5A, BC5B,
    - iv. BC5XX, BC5YY, BC5ZZ.
  - (b) External type (the variables are not time dependent in the lists) : BC5HO.
3. SAFETYVA (internal type)

When modifying a BC3A ... BC3H or BC5XX, BC5YY or BC5ZZ, give only the variables lists to be modified (see example 1).

When modifying a BC4A, B, C or BC5A, B, as LAW is not available in command block, give data in the directive (see example 2).

When using BLIND condition, you should define liquid and gas velocities (see example 3).

### BEWARE that:

1. **you cannot change a BC of the internal type for the external type with BCMOD directive (exception is made for BC5HO type),**
2. **you can only change BC5HO type for BC5HO type or for BLIND type.**

### Associated Keywords

MODEL, BCONDIT, MONOPHAS(E)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 54/ <a href="#">851</a>

### Syntax

```
BCMOD      elem      bctype
              (DTOPEN    dt1)           (DTCLOSE   dt2)           ;

```

**Syntax of the boundary condition (see MODEL directive) :**

<b>elem</b>	: bcondit element.
<b>bctype</b>	: new type of boundary condition.
<b>DTOPEN</b>	: OPTIONAL keyword followed by a real number >0 available only in case of use of a <b><i>BC5HO boundary condition type</i></b> . dt1 is the time to obtain (a) fully opened condition(s).

**NB** : This is used to represent the opening of a manhole, changing BLIND to BC5HO condition in dt1 seconds (see example 5).

<b>DTCLOSE</b>	: OPTIONAL keyword followed by a real number > 0 in case of the use of a <b><i>BLIND boundary condition type only</i></b> . dt2 is the time necessary to obtain a fully closed condition(s).
----------------	--

**NB** : This is used to represent the closing of a manhole, changing BC5HO to BLIND condition in dt2 seconds (see example 4).

### Example

#### Example 1

```
BCMOD  entrei  BC3A
HL     (REALLIST -1.        -1.        -1.        )
VL     (REALLIST  vlxr1     vlxr2     vlxr3     )
VV     (REALLIST  vlxr1     vlxr2     vlxr3     ) ;
```

#### Example 2

```
BCMOD  break   BC5A
P      REALIST 150.D5    140.D5    100.D5
ABSTIME  REALIST 0.D0     10.D0     500.D0 ;
```

#### Example 3

```
BCMOD  break   BLIND    VL       1.D0    VV       1.D0    ;

```

#### Example 4

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 55/ <a href="#">851</a>

(closing of a manhole)

```
BCMOD      manhole      BLIND      DTCLOSE     1.D0      ;
```

#### **Example 5**

(opening of a manhole)

BCMOD	manhole	BC5HO
	TLIQEXT	20.D0
	TGASEXT	20.D0
	ALFAEXT	0.99999
	X1EXT	0.9
	X2EXT	0.D0
	X3EXT	0.D0
	GAMEXT	0.D0
	PEXT	1.D5
	DTOPEN	1.D0 ;

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is BCMOD :

```
CALL BCMOD (OBJNAM,CTYPBC,NCVAL,NRVAL,CVAL,RVAL,*)
```

NRVAL	INTEGER number of points of the REALLISTs
NCVAL	INTEGER number of variables
CVAL(NCVAL)	CHARACTER*8 array gathering the names of the variables
RVAL(NCVAL*NRVAL)	DOUBLE PRECISION array gathering all the REALLISTs
OBJNAM	CHARACTER*8 name of the objet
CTYPBC	CHARACTER*8 type of the objet

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 56/851

12

## BCONDIT GROUP OPERATOR

The **BCONDIT GROUP** operator creates a BCONDIT element of type **GROUP** in the *data block*. This operator must be coupled at least with the use of the **JUNCTION GROUP**, **AXIAL GROUP** and **ZONE** operators.

### Associated Keywords

**JUNCTION GROUP**, **AXIAL GROUP**, **WALL GROUP**, **FUELCHAR GROUP**, **BCONDIT GROUP**, **ZONE**, **CIRCUIT**, **PERMINIT**, **REALC**

### Syntax

```
junam =      BCONDIT      GROUP      junc1      sense1 ;
```

junam <b>BCONDIT GROUP</b> junc1 sense1	: Name of the <b>BCONDIT GROUP</b> element. It must not exceed 5 characters. : Keywords which specifies that a BCONDIT element of type <b>GROUP</b> is defined. : junction of type <b>GROUP</b> followed by a keyword which defines the orientation of the junction in the element. This keyword is <b>USTREAM</b> or <b>DSTREAM</b> .
---	--

**Warning** : check that for the other element related to this junction, the other keyword is used.

### Example

First, the **JUNCTION GROUP** bota must be declared.

```
bota=      JUNCTION      GROUP      157      SUFFIX      1  
          WEIGHT       CONST      264      ;
```

Then, the **BCONDIT GROUP** enta can be defined: enta will contain 157 identical junctions called enta001 to enta157.

```
enta=      BCONDIT      GROUP      bota      DSTREAM      ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 57/851

# 13

## BCONDIT OPERATOR

The **BCONDIT** operator creates a boundary condition element in *data block*.

### Associated Keywords

BCMOD, MODEL, LOWPRESS, VALBA FOR BC, WRIBA FOR BC, VALUE FOR BC, WRITE FOR BC

### Syntax

```
elem =      BCONDIT    junc1      sense1      WEIGHT      ip;
```

**elem** : name of the boundary condition element

**junc1 sense1** : junction followed by a keyword which defines the orientation of the junction in the element. This keyword is **USTREAM** or **DSTREAM**.

**Warning** : check that for the other element related to this junction, the other keyword is used.

**WEIGHT ip** : OPTIONAL keyword followed by a positive integer which defines the weight of the element. The weight default value is 1.

**Definition** : the weight of an element is the number of identical real elements that it simulates. The weight is used in mass and energy balances.

### Example

```
inputi =      BCONDIT    feedi      DSTREAM      WEIGHT 2 ;
```

```
inputr =      BCONDIT    feedr      DSTREAM      ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 58/851

14

## BEGIN DATA DIRECTIVE

The **BEGIN DATA** directive is the compulsory first instruction of the *data block*.

### Associated Keywords

END DATA, END EXEC

### Syntax

**BEGIN**      **DATA ;**

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 59/851

15

## BILAN3D DIRECTIVE

The **BILAN3D** directive enables the user to define within a THREED element type, at the end of the *data block*, 3D ZONE in which mass and energy balance are computed. These balances are printed in the listing after the THREED element current printings. They are also written in the result file FORT21 (binary) or FORT20 (formatted) with the THREED element result storage frequency.

### Associated Keywords

**THREED, INIBIL, ZONE**

### Syntax

<b>BILAN3D</b>	<b>elem</b>	3dzonam1
		(...)
		3dzonnamn ;
<b>or</b>		
		3dzonam1      ibeg      iend
		jbeg      jend
		kbeg      kend
		(...)
		3dzonamn      ibeg      iend
		jbeg      jend
		kbeg      kend ;

**elem** : name of the threed element.

**3dzonam1...** : names of 3D zones. The 3D zones have to be first defined in the MESH directive by using ZONEDEF keyword otherwise they should be followed by :

**ibeg iend** : 6 integers for velocity node plane number boundary of the defined 3D zone. To exist, the 3D zone shall verify the following conditions : ibeg < iend, jbeg < jend, kbeg < kend.

**jbeg jend**

**kbeg kend**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 60/ <a href="#">851</a>

### Example

Assuming that ZON1, ZON2 and ZON3 are already defined in MESH directive of the THREED element CUVE3D, the following syntax is possible :

```
BILAN3D CUVE3D    ZON1
                  ZON2
                  ZON3
                  ZON4    1 2       5 6       1 21 ;
```

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 61/ <a href="#">851</a>

# 16

## BLKROTOR DIRECTIVE

The **BLKROTOR** directive is used, in the *command block*, to simulate the lock of a pump rotor by modification of the singular head losses at the point where the pump is located.

### Associated Keywords

PUMPCHAR, PCAVIT, PUMPMOD, STOPPUMP, STARPUmp

### Syntax

```
BLKROTOR elem      (FRACTION frac)      (DELAY dtlock)      ;
```

elem : name of the pumpchar element whose rotor is to be locked

FRACTION frac : OPTIONAL keyword followed by a real number ( $0 \leq \text{frac} \leq 1$ ) allowing to change the torque loss coefficient applied for locking the rotor ( $K = \text{frac} \cdot 10^{10}$ ). ( $\text{frac} = 1$  is the default value)

DELAY dtlock : OPTIONAL keyword followed by a positive real number giving the time delay (in seconds) between the time at which the directive is used and the total rotor lock. (0. is the default value)

### Example

```
BLKROTOR carpo1
IF      (xpres<129.D5 AND      iarurg EQ 0)      ;
      BLKROTOR pumprra1      DELAY 5.      ;
ENDIF ;
```

**NB :** The corresponding FORTRAN subroutine called in PILOT is POBLK.f : POBLK (OBJNAM, FRACTION, DELAY, \*9999)

OBJNAM	name of the pumpchar element (character*8)
FRACTION	Real number equal to the fraction of the “total” head loss
DELAY	Real number equal to the delay for total rotor lock

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 62/851

17

## BREAK OPERATOR

The **BREAK** operator creates a break object in *data block*. A break has to be defined on an AXIAL element.

The break will be modeled by a sink, implicitly coupled to the pipe. The critical flow is calculated using the Gros D'Aillon correlation.

**NB1** : A break can also be modeled by a BC4A or BC4B boundary condition using the of characteristics method to calculate the sonic velocities. Using BC4A or BC4B gives then more precise results about critical flow computation.

A break can also be modeled by a PIQBREK gadget. It calculates sonic (using Gros D'Aillon correlation) or subsonic flowrates, or even reverse flow with respect to the outside pressure.

**NB2** : The BREAK operator **does not open the break** in the element, **it only defines the object** (see ENABLE, DISABLE directives).

### Associated Keywords

ENABLE, DISABLE, PIQBREK, VALBA FOR A BREAK, VALUE FOR A BREAK

### Syntax

<b>B = BREAK</b>	<b>AXIAL</b>	<b>elem ip</b>	
	<b>(SINGULAR</b>	<b>z1)</b>	
	<b>SECT</b>	<b>z2</b>	
	<b>LENGTH</b>	<b>z3;</b>	
or			
<b>B = BREAK</b>	<b>AXIAL</b>	<b>elem</b>	<b>SAFETYVA ip</b>
	<b>(SINGULAR</b>	<b>z1)</b>	
	<b>SECT</b>	<b>z2</b>	
	<b>LENGTH</b>	<b>z3</b>	
	<b>PRESSURE</b>	<b>z4</b>	
	<b>DELTAPE</b>	<b>z5;</b>	

**AXIAL elem** : keyword indicating that the break is modeled on a pipe followed by the name of the axial element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 63/ <a href="#">851</a>

- SAFETYVA** : OPTIONAL keyword indicating that the break-safety valve model will be used
- ip** : scalar point of the element.
- SINGULAR z1** : OPTIONAL keyword. If it is used, it is followed by a real number which defines a singular head loss coefficient. (The default value of z1 is 0.).
- SECT z2** : keyword followed by a real number >0. defining the cross section of the break ( $m^2$ ).
- LENGTH z3** : keyword followed by a real number >0. defining the length of the nozzle (m).

In case of SAFETYVA modeling :

- PRESSURE z4** : keyword followed by a real number >0. defining the calibration pressure for the safety valve (Pa).
- DELTAP z5** : keyword followed by a real number >0. defining the pressure at maximum opening of the safety valve (Pa)

#### Example

```

break1 =      BREAK AXIAL coldr ip SECT 1.824d-2 LENGTH 0.335 ;
break2 =      BREAK AXIAL coldr ip SINGULAR 0.445
              SECT 1.824d-2 LENGTH 0.335 ;
break3 =      BREAK AXIAL coldr SAFETYVA ip
              SECT 1.824d-2 LENGTH 0.335
              PRESSURE 50.D5 DELTAP 5.D5 ;

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 64/ <a href="#">851</a>

18

## BRUTEF77 DIRECTIVE

The **BRUTEF77** directive places FORTRAN instructions provided by the user in the Executable Block directly into the PILOT.f subroutine (translation of the calculation scenario). This directive allows control statements during the processing, or additional steps for the scenario. This operator can be used only in the *Exec Block*.

Please note the **WARNING** section for restrictions of use.

### Associated Keywords

**BRUTEF77**

### Syntax

**BRUTEF77** ‘INSTRUCTION’

**INSTRUCTION** : any valid FORTRAN instruction in the PILOT.f subroutine context

**N.B :** The FORTRAN instruction is simply introduced in PILOT.f with no other control by the reader

### Example

**BRUTEF77** ‘ WRITE (6,\*) “ The directive is OK “ ‘

During the execution of the scenario, this will add in the output listing the sentence ‘The directive is OK’.

The whole FORTRAN statement must be enclosed with simple quotes “ ; inside this simple quotes, if needed, FORTRAN character strings must be enclosed with double quotes “ ” – these double quotes are automatically converted to FORTRAN simple quotes to conform with ANSI Standards in PILOT.f

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 65/ <a href="#">851</a>

## WARNING

Although this directive covers a very wide range of applications, it is better to limit its use only for short test or debug instructions within the scenario (Block Exec). Interpreted directives should always be preferred to build the Executable Block for calculation studies. The use of BRUTEF77 directives assumes that the user is familiar with the FORTRAN language and with the PILOT subroutine context (declared variables and common blocks). If the resulting FORTRAN instruction is not correct, the compiler used to compile and link the final **CATHARE** executable (cathar.exe) may produce an error and it is of the user's responsibility to check for final correctness.

BRUTEF77 directive will be obsolescent for **CATHARE3**.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 66/ <a href="#">851</a>

19

## BYPASS DIRECTIVE

The **BYPASS** directive (used in the data block) allows to specify neutronic properties for an AXIAL element modeling a bypass of a core:

1. amount of neutronic power released in the fluid,
2. anti-reactivity coefficients for the moderator,
3. anti-reactivity coefficients related to boron concentration.

The BYPASS directive can only be defined on an **axial hydraulic element**.

The power and anti-reactivity profiles are defined for meshes located inside a segment of the axial meshing. Several segments can be defined, but a mesh must appear only once.

In the data block, BYPASS directive must be used before CORE operator.

### Associated Keywords

POWER, AXIAL

### Syntax

<b>BYPASS</b>	<b>elem</b>	<b>COEFBNEU</b> <b>COEFBB</b> or <b>FCOEFBB</b> <b>SEGMENT</b> <b>PROFILE</b>	<b>coefbneu</b> <b>(DENSITY)</b> <b>coefbba</b> <b>(DENSITY)</b> <b>Pi</b> <b>ZBPOWNR</b>	<b>COEFBM</b> <b>coefbb</b> <b>coefbbb</b> <b>coefbbc</b>	<b>coefbm</b> <b>coefbbb</b> <b>coefbbc</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 67/851

<b>(AZBBOR</b>	<b>AZINI</b> <b>AZEND</b> az1 or list1 or	azini azend
<b>(SEGMENT</b>	<b>AZINI</b> <b>AZEND</b> Pk	azini azend Pl.....);

- elem** : axial element.
- COEFBNEU** : keyword followed by a real number > 0 defining the neutronic power coefficient for the BYPASS axial sub element type, that is the peak factor on the neutronic received by the BYPASS with respect to the nominal core neutronic power.
- COEFBM** : keyword followed by a real number > 0. defining the **anti-reactivity** coefficient resulting from moderator density variation for the BYPASS (in dollar that is pcm/BETApcm). The moderator effect anti-reactivity term is expressed in the following form :  $R = \text{coefbm} * [r(t) - r(0)]$
- COEFBB (DEN-SITY)** : **COEFBB** keyword describes the anti-reactivity resulting from boron effect by using the integration method.
- coefbba  
coefbbb  
coefbbc
- if **DENSITY** keyword is used, the anti-reactivity ( $R$  in \$) is computed as a function of the liquid density of the fluid and the soluble boron concentration ( $C_b$ ) in mass of boron (in kg) per mass of liquid water (in kg) by its differential:
- $$\frac{dR}{dC_b} = \text{coefbba} \cdot \rho_L + \text{coefbbb} \cdot \rho_L^2 \cdot C_b$$
- By default, the antireactivity ( $R$  in \$) is computed as a function of the soluble boron concentration ( $C_b$ ) in mass of boron (in kg) per mass of liquid water (in kg) by its differential:
- $$\frac{dR}{dC_b} = \text{coefbba} + \text{coefbbb} \cdot C_b$$
- with:
- coefbba, coefbbb:** two real positive numbers ( $R$  is an increasing function of  $C_b$ )  
**coefbbc:** a real number > 0 defining the radial anti-reactivity coefficient.
- Note:** when the integration method is used, the axial anti-reactivity coefficients have to be given (see **AZBBOR** keyword)
- FCOEFBB (DENSITY)** : **FCOEFBB** keyword describes the anti-reactivity resulting from boron effect by using the function method.
- coefbba  
coefbbb
- if **DENSITY** keyword is used, the anti-reactivity ( $R$  in \$) is computed as a function of the liquid density of the fluid and the soluble boron concentration ( $C_b$ ) in mass of boron (in kg) per mass of liquid water (in kg) by its differential:
- $$\frac{dR}{dC_b} = \text{coefbba} \cdot \rho_L + \text{coefbbb} \cdot \rho_L^2 \cdot C_b$$

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 68/851

By default, the antireactivity ( $R$  in \$) is computed as a function of the soluble boron concentration ( $C_b$ ) in mass of boron (in kg) per mass of liquid water (in kg) by its differential.

$$\frac{dR}{dC_b} = \text{coefbba} + \text{coefbbb} \cdot C_b$$

with **coefbba**, **coefbbb** : the two real positive numbers ( $R$  is an increasing function of  $C_b$ )

<b>SEGMENT</b> <b>Pi Pj</b> <b>PROFILE</b> <b>ZBPOWNR</b> <b>puis1</b> <b>list1</b> <b>PINI puisini</b> <b>PEND puisend</b> <b>AZBMOD</b> <b>az1</b> <b>list1</b> <b>AZINI azini</b> <b>AZEND azend</b>	<p>: keyword indicating that a segment is to be read and upon which profiles are to be defined. This is followed by :</p> <p>: pair of vector points which must belong to the mesh of the axial element and which defines the start and the end of the segment.</p> <p>: keyword indicating that the power and anti-reactivity linear profiles will be given. This keyword is followed by:</p> <p>: keyword indicating that the <u>neutronic power profile</u> will be given. If this profile is <u>constant</u> along the segment, a constant value is given:            : real number <math>&gt; 0</math> defining a constant non residual power profile. Whatever real number is given, the constant profile is equal to 1 everywhere.            The profile can be given on <u>each axial mesh</u> of the segment.            : realist object (see REALLIST operator) defining the neutronic power profile value on each axial mesh of the segment.            The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the neutronic power profile at the start of the segment (vector point).</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the neutronic power profile at the end of the segment (vector point).</p> <p>: keyword indicating that the profile for the anti-reactivity resulting from <u>moderator density variations</u> will be given.            If this profile is <u>constant</u> along the segment, a constant value is given:            : real number <math>&gt; 0</math>. defining a constant profile for the anti-reactivity resulting from moderator density variations. Whatever real number is given, the constant profile is equal to 1 everywhere.            The profile can be given on <u>each axial mesh</u> of the segment.            : realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from moderator density variations on each axial mesh of the segment            The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the start of the segment (vector point).</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the end of the segment (vector point).</p>	<b>to be repeated as many times as there are number of segments</b>
---	--	---

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i></p>
<b>Document technique DEN</b>	Page 69/ <a href="#">851</a>

<b>AZBBOR</b>	<p>: keyword indicating that the profile for the anti-reactivity resulting from the <u>boron effect</u> will be given. This keyword has to be used only when the integration method ( <b>COEFBB</b> keyword) has been chosen. If this profile is <u>constant</u> along the segment, a constant value is given:</p>
<b>az1</b>	<p>: real number &gt; 0. defining a constant profile for the anti-reactivity resulting from moderator density variations. Whatever real number is given, the constant profile is equal to 1 everywhere.</p>
<b>list1</b>	<p>The profile can be given on <u>each axial mesh</u> of the segment.</p> <p>: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from moderator density variations on each axial mesh of the segment</p> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p>
<b>AZINI azini</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the start of the segment (vector point).</p>
<b>AZEND azend</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the end of the segment (vector point).</p>

**to be repeated as many times**

**as there are number of segments**

### Example

```
FZPOW10 = REALLIST 0.8 0.9 1.0 1.1 1.2 1.2 1.1 1.0 0.9 0.8 ;
FZMOD10 = REALLIST 0.8 0.9 1.0 1.1 1.2 1.2 1.1 1.0 0.9 0.8 ;
FZBOR10 = REALLIST 0.8 0.9 1.0 1.1 1.2 1.2 1.1 1.0 0.9 0.8 ;
```

<b>BYPASS</b>	<b>BYPAXT1</b>	<b>COEFBNEU</b>	
		0.2D0	
	<b>COEFBM</b>	1.D-2	
	<b>FCOEFBB</b>	<b>DENSITY</b>	1.D-3 5.D-3
	<b>SEGMENT</b>	B00EXT	B10EXT
	<b>PROFILE</b>	<b>ZBPOWNR</b>	FZPOW10
	<b>AZBMOD</b>	FZMOD10 ;	

<b>BYPASS</b>	<b>BYPAXT2</b>	<b>COEFBNEU</b>	<b>0.2D0</b>	
	<b>COEFBM</b>	1.D-2		
	<b>COEFBB</b>	1.D-1	5.D-1	0.5
	<b>SEGMENT</b>	B00EXT	B10EXT	
	<b>PROFILE</b>	<b>ZBPOWNR</b>	FZPOW10	
	<b>AZBMOD</b>	FZMOD10		
	<b>AZBBOR</b>	FZBOR10 ;		

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 70/851

20

## CANDLE OPERATOR

The **CANDLE** operator creates, in data block, a pure energy sink or source by defining its characteristics. Candles can be defined up to 200 in the standard reader. A CANDLE can be defined on an AXIAL or VOLUME or THREED element. The CANDLE operator only defines and locates a CANDLE and does not activate it (see ENABLE, DISABLE).

A CANDLE describes :

1. the injection of energy into the liquid or gas phases of the element without phase change. Used keywords are LIQUID, LIQPOWER, GAS, GASPOWER and INJECVOL.
2. the quantity of energy being injected in the mixture and directly used in phase change. Used keywords are INTERLIQ and INTERGAS.

Two types of injection can be defined :

1. **INTERNAL CANDLE** : The injection is automatically controlled within the computation. Control is made by giving an evolution law when the CANDLE is defined.
2. **EXTERNAL CANDLE** : Injection controlled by the user in the executable block of the data set, using **CATHARE** Computation Variables (**CCV**). The **CCV**'s applicable for the volume, threed and axial element are given in **WRITE** directive. The **CCV** data set must be defined before the **ENABLE** directive. Depending on the kind of injection, mandatory data to set are the following

For **1-D** or **3-D** element :

liquid	⇒ and	WRITE WRITE	LIQPOWER INTERLIQ	Power (w) Power (w)
gas	⇒ and	WRITE WRITE	GASPOWER INTERGAS	Power (w) Power (w)

For **VOLUME** element:

liquid	⇒	WRITE	INJECVOL	Power (w)
--------	---	-------	----------	-----------

### **Geometry and location of the CANDLE :**

The only differences between a CANDLE defined on an **1-D** or a **0-D** or a **3-D** element are the following :

1. On an **1-D** element, a CANDLE should be defined on a scalar point of the element.
2. On a **0-D** element the elevation is required to locate the candle.



3. On an **3-D** element, a CANDLE should be defined on a mesh number of the element.

The user must specify the type of element on which the CANDLE is defined.

### **Associated Keywords**

ENABLE, DISABLE, VALUE FOR CANDLE, WRITE FOR CANDLE

## Syntax

#### For an internal CANDLE:

S1 =	<b>CANDLE</b>	type-element	element (ip)	<b>INTERNAL</b>
	or		<b>ELEV</b>	elevi
				(if volume)
	<b>INJECLAW</b>			<b>LIQUID</b>
		or		<b>GAS</b>
		or		<b>INTERLIQ</b>
		or		<b>INTERGAS</b>
		or		<b>INJECVOL</b>
	lawj	;		(if volume)

For an external CANDLE :

<b>type-element</b>	: AXIAL or VOLUME or THREED.
<b>element</b>	: element name.
<b>INTERNAL</b>	: keyword to indicate that the CANDLE is an internal candle. For an external candle, the keyword <b>INTERNAL</b> will be replaced by the keyword <b>EXTERNAL</b> .
<b>ip</b>	: only for AXIAL or THREED element. If axial element, scalar point of the meshing of the element. If threed element, the mesh number of the element.
<b>ELEV elevi</b>	: only for a VOLUME element. keyword followed by a real number ; this number defines the elevation of the CANDLE with respect to the bottom of the volume and must be $\geq 0$ and $\leq$ height of the volume. If elevi is in the : - lower sub-volume, power is injected in the liquid phase of the lower sub-volume, - upper sub-volume, power is injected in the gas phase of the upper subv-olume. : keyword for an INTERNAL CANDLE to indicate that an injection law is going to be defined
<b>INJECLAW</b>	

Four possibilities can follow in the CANDLE specifications :

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 72/851

#### For the AXIAL or THREED element

**LIQUID** : keyword to indicate that the CANDLE injects power into the liquid phase without changing the liquid to interface heat flux.  
 or  
**GAS** keyword to indicate that the CANDLE injects power into the gas phase without changing the vapor to interface heat flux.  
 or  
**INTERLIQ** : keyword to indicate that the CANDLE changes power from the liquid phase with changing the liquid to interface heat flux.  
 or  
**INTERGAS** keyword to indicate that the CANDLE changes power from the gas phase with changing the vapor to interface heat flux.

#### For the VOLUME element

**INJECVOL** : keyword to indicate that the CANDLE injects power into the volume element liquid or gas phase (depending on the elevation of the CANDLE compared to the level of the volume) without changing the interface heat flux.  
  
**Lawj** : law defining the power injected (positive value) or extracted (negative value) as a function of time.

**WARNING** : the user should define the injection law before the CANDLE definition.

#### Examples

```
LAWI =      LAW      'ABSTIME'    'POWER'  
           0.0D0      -30.0D03  
           1.0D5      -30.0D03      ;
```

#### Candles on an axial element

IPI = SCALAR PIPENAME 1.3 ;

CE1 =	CANDLE	AXIAL	pipenam	INTERNAL	ipi
	INJECLAW	LIQUID	lawi ;		
CE2 =	CANDLE	AXIAL	pipenam	INTERNAL	ipi
	INJECLAW	GAS	lawi ;		
CE3 =	CANDLE	AXIAL	pipenam	INTERNAL	ipi
	INJECLAW	INTERLIQ	lawi ;		
CE4 =	CANDLE	AXIAL	pipenam	INTERNAL	ipi
	INJECLAW	INTERGAS	lawi ;		
...					

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 73/851

CE10 =            CANDLE            AXIAL            pipenam            EXTERNAL            ipi ;  
 WRITE            - 30.0D0            INTERLIQ            CE10 ;

#### Candles on a volume element

CV1 =            CANDLE            VOLUME            volnam            INTERNAL            ELEV            0.2  
 INJECLAW            INJECVOL            lawi ;  
 ...

CV10=            CANDLE            VOLUME            volnam            EXTERNAL            ELEV            0.2 ;  
 WRITE            -30.0D0            INJECTVOL            CV10 ;

#### Candles on an 3 Dimensional element

C31 =            CANDLE            THREED            3Dnam            INTERNAL            5  
 INJECLAW            LIQUID            lawi ;  
 C32 =            CANDLE            THREED            3Dnam            INTERNAL            5  
 INJECLAW            GAS            lawi ;  
 C33 =            CANDLE            THREED            3Dnam            INTERNAL            5  
 INJECLAW            INTERLIQ            lawi ;  
 C34 =            CANDLE            THREED            3Dnam            INTERNAL            5  
 INJECLAW            INTERGAS            lawi ;

C310 =            CANDLE            THREED            3Dnam            EXTERNAL            5 ;

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 74/ <a href="#">851</a>

21

## CATAFUEL OPERATOR

The **CATAFUEL** operator, used in *data block*, creates a catafuel element for a standalone fuel calculation. It comes after the definition of a hydimp element, created with the HYDIMP operator. The catafuel object has roughly the same function as a reactor object in a hydraulics calculation. For example, the TRANFUEL directive is applied to a catafuel object in the same way as the TRANSIENT directive is applied to a reactor object.

There are two different ways to supply the imposed hydraulic conditions to a standalone fuel rod :

1. **Option 1:** Standalone fuel calculation with an external hydraulic file. **Be careful that this external file does not contain any tabulation characters.**

WARNING: This possibility is available only for 1D hydraulic components (AXIAL)

The external hydraulic file contains one fluid condition set only. For this option only one standalone fuel calculation is possible and only one hydimp element is allowed in the CATAFUEL operator (refer to the CATHARE2 user manual). The user must use the **READHEXT** directive to read the hydraulic conditions relative to a time step in the file.

2. **Option 2:** Standalone fuel calculation with a **CATHARE** hydraulic file.

WARNING: This possibility is available for 1D hydraulic components (AXIAL) and a 3D hydraulic component (THREED)

The **CATHARE** hydraulic file is the result of a previous **CATHARE** calculation (the original calculation) where one or several hydraulics have been saved with the **STOREHYD** directive. It should be named FORT63 to be recognised. Each hydimp element (elem1...elemn) must be defined before the CATAFUEL operator by the **HYDIMP** operator. The order of hydimp elements in the CATAFUEL operator must take into account the order of the hydraulics in **STOREHYD** directive. The print-outs concerning each element will appear in the order of the elements listed in the CATAFUEL operator.

Option 2 with non-condensable gases: If the original calculation has been performed with non-condensable gases, the same noncond element **must** be specified in the CATAFUEL operator (same number of gases, same gases and gas names, same gas properties). See example 2.

Option 2 with neutronics: If the original calculation has been performed with neutronics, the keyword NEUTRO **must** be specified in order to retrieve, in the hydraulic file, the whole power generated in the fuel rods. See example 3.

**NB:** The previous external hydraulic files (since V1.5 version) are compatible with **CATHARE2** present version. The previous **CATHARE** hydraulic files are not compatible.

A complete description of the CATAFUEL module may be found in the **CATHARE2** user manual document.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 75/851

### Associated Keywords

COMPHYD, HYDIMP, HYDMOD, READHCAT, READHEXT, STDYFUEL, TRANFUEL, STOREHYD, HYDCHAN, RESHCAT, PICTG

### Syntax

1. Option 1 :

```
cata=      CATAFUEL elem1      FILE      n1 ;
```

2. Option 2 :

```
cata=      CATAFUEL elem1      ...      elemn
          (NEUTRO) (noncox);
```

**cata** : name of the catafuel element.

**elem1 ... elemn** : list of hydimp elements. Several elements are allowed only in case of option 2.

**NEUTRO** : Keyword specifying that the hydraulic conditions have been calculated with neutronics (option 2 only). MANDATORY for calculations performed with neutronics.

**noncox** : noncond object defining the non-condensable gases transported in the catafuel hydraulics (option 2 only). MANDATORY for calculations with non-condensable gases

**FILE n1** : Keyword defining the logical unit number of the hydraulic condition file (option 1 only). The range of possible values for the logical unit number is 62 or 63 and 66 to 77 (63 is highly recommended).

### Examples

#### Example 1

##### **1D CATHARE calculation**

###### Original hydraulics calculation:

```
STOREHYD axial1      axial2      axial3 ;
circ =      CIRCUIT      ...      axial1      axial2      axial3      ...
END DATA ;
```

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 76/ <a href="#">851</a>

Standalone fuel calculation:

```

hydimp1 =      HYDIMP      axial1 ;
hydimp2 =      HYDIMP      axial2 ;
hydimp3 =      HYDIMP      axial3 ;
...
cata1 =        CATAFUEL   hydimp1    hydimp2    hydimp3 ;
*cata2 =       CATAFUEL   hydimp1    hydimp3 ; *****
*cata3 =       CATAFUEL   hydimp3    hydimp2 ; *****
                                         Bad order of
                                         Allowed
                                         Not allowed
                                         elements (see STOREHYD)

```

### Example 2

#### **1D CATHARE calculation with non-condensable gases**

Original hydraulics calculation:

```

...
STOREHYD      axial1      axial2 ;
...
noncond1 =     NONCOND    2          HYDROGEN  NITROGEN ;
circ =         CIRCUIT    axial1    axial2      noncond1 ;
...
END DATA ;

```

Standalone fuel calculation:

```

hydimp1 =      HYDIMP      axial1 ;
hydimp2 =      HYDIMP      axial2 ;
...
noncond1 =     NONCOND    2          HYDROGEN  NITROGEN ;
cata1 =        CATAFUEL   hydimp1    hydimp2    noncond1 ;
...

```

### Example 3

#### **1D CATHARE calculation with neutronics**

Original hydraulics calculation:

```

core1 =        CORE ... ;
...
STOREHYD      axial1      axial2      NEUTRO ;
...
circ =         CIRCUIT    axial1      axial2      core1 ;
...
END DATA ;

```

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 77/851

Standalone fuel calculation:

```

hydimp1 = HYDIMP axial1 ;
hydimp2 = HYDIMP axial2 ;
...
cata1 = CATAFUEL hydimp1 hydimp2 NEUTRO ;
...

```

**Example 4**

**Case of a catafuel computation with a threed component**

NB :

First the 1D hydraulic channels have to be defined within the threed component.

Fuelch1, Fuelch2, Fuelch3 are linked to the threed component.

The 1D hydraulic channels to be stored in the external hydraulic file have to be selected by using STOREHYD directive.

Original hydraulics calculation:

```

hydchan1 = HYDCHAN Fuelch1 ;
hydchan2 = HYDCHAN Fuelch2 ;
hydchan3 = HYDCHAN Fuelch3 ;

```

```

STOREHYD 3dnam
          hydchan1
          hydchan2
          hydchan3 ;
END DATA ;

```

Standalone fuel calculation:

```

hydimp1 = HYDIMP hydchan1 ;
hydimp2 = HYDIMP hydchan2 ;
hydimp3 = HYDIMP hydchan3 ;
...
cata1 = CATAFUEL hydimp1 hydimp2 hydimp3 ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 78/851

22

## CCFL OPERATOR

The **CCFL** operator, used in the *data block*, creates a ‘CCFL’-type object either at the junction between a *volume* and a *pipe*, in a *pipe* or in a *threed* element.

The CCFL operator allows the user to select any of the Wallis, Kutateladze, Bankoff or Tien form of the flooding equation by specifying the parameters M, C, E and X

The **CCFL** operator only defines and locates the CCFL object, **it does not enable it** (see **ENABLE, DISABLE**).

### Associated Keywords

**ENABLE, DISABLE**

### Syntax

ccfl_name = <b>CCFL</b> <b>JUNCTION</b> pipe_name      volume_name or <b>POINT</b> pipe_name      vec_point or <b>THREED</b> pipe_name      threed_name <b>X</b> (or <b>Y</b> )      (or <b>Z</b> )      node_number or <b>LX</b> (or <b>LY</b> )      (or <b>LZ</b> )      npt node1          node2          ...          nodenpt or <b>FXZONE</b> (or <b>FYZONE</b> or <b>FZZONE</b> ) zone_definition <b>SRATIO</b> sratio <b>DIAM</b> diam <b>MCCFL</b> mccfl            or <b>FMCCFL</b> <b>CCCFL</b> cccfl            or <b>FCCCFL</b> <b>ECCFL</b> eccfl            or <b>FECCFL</b> <b>XCCFL</b> xccfl            ;  <b>ccfl_name</b> : ‘ccfl’ type object <b>JUNCTION</b> : Keyword indicating that the <b>CCFL</b> computation is located at a junction between a pipe and a volume. This is followed by :
--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 79/851

<b>pipe_name</b>	: Names of the pipe and the volume where the CCFL is located.
<b>volume_name</b>	
<b>POINT</b>	: Keyword indicating that the ccfl computation is located inside a pipe. This is followed by :
<b>pipe_name</b>	: Names of the pipe and the vector point where CCFL is located.
<b>vec_point</b>	
<b>THREED</b>	: Keyword indicating that the ccfl computation is located on one or several velocity nodes of a threed element. It is followed by :
<b>threed_name</b>	: name of the threed module which contains the ccfl object.

The flowing data aim at locating **CCFL** in the THREED element using vector node numbering (2 first possibilities) or vector zone numbering (the last one).

For further information about numbering in a threed element refer to user manuel.

<b>X (or Y or Z)</b>	: Keyword indicating that the ccfl computation is only on one VX (or VY or VZ) node. It is followed by :
<b>node_number</b>	: Integer, corresponding to the vector node number (using vector node numbering in the chosen direction) carrying the CCFL computation.
<b>LX (or LY or LZ)</b>	: Keyword indicating that the CCFL computation is located on several velocity points of type VX (or VY or VZ). It is followed by :
<b>npt</b>	: Integer, corresponding to the number of velocity nodes carrying the CCFL computation, and :
<b>node1 ... nodenpt</b>	: Integers, corresponding to the npt vector node numbers (using vector node numbering in the chosen direction) carrying the ccfl computation.
<b>FXZONE (or FYZONE or FZZONE) zone_definition</b>	: Keyword indicating that the CCFL computation is located on velocity nodes of VX (or VY or VZ) type, defined by a one node thick zone. It is followed by :  : Name of a global vector zone already defined in MESH directive or 6 integers for velocity plane number for zone boundary definition. The thickness of the zone in the velocity direction shall be one node.
<b>SRATIO sratio</b>	: Keyword followed by a real > 0. sratio which is the ratio of the modeled flow section to the real flow section.
<b>DIAM diam</b>	: Keyword followed by a real > 0. diam which is the length used to define the non dimensional velocity and the Bond number.
<b>MCCFL mccfl</b>	: Keyword followed by a real > 0. defining the value of the M parameter.
<b>FMCCFL</b>	: Keyword indicating that the M parameter will be calculated by the user in routine FMCCFL.
<b>CCCFL cccfl</b>	Keyword followed by a real > 0. defining the value of the C parameter.
<b>FCCCFL</b>	Keyword indicating that the C parameter will be calculated by the user in subroutine FCCCFL.
<b>ECCFL eccfl</b>	Keyword followed by a real $\geq 0$ . defining the value of the E parameter.
<b>FECCFL</b>	Keyword indicating that the E parameter will be calculated by the user in subroutine FECCFL.
<b>XCCFL xccfl</b>	OPTIONAL keyword followed by a real ( $0 < xccfl \leq 1$ ). defining the value of the X parameter. Default value is 0.5.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 80/ <a href="#">851</a>

**Example**

```
ccflcore = CCFL      THREED      cuve
           FZONE      1 13 1 3 1 1
           SRATIO     1.
           DIAM       0.01
           MCCFL      0.9
           CCCFL     1.
           ECCFL      0.9
           XCCFL     0.4
                           ;
```

 <b>ce<sub>a</sub></b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 81/ <a href="#">851</a>

23

## CHAR8 DIRECTIVE

This directive of the *command block* allows the declaration of the **CHARACTER\*8** -type variables that will be used in the command block.

It must be used at the top of the command block, BEFORE ANY executable statement such as RESTORE, OPTION...

It can be used one or several times, anywhere among other declarations like INTEGER and DOUBLE.

CHARACTER\*8 variables are not SAVED in V25\_3.RESTART so you **cannot restore** them.

### Associated Keywords

INTEGER, DOUBLE

### Syntax

**CHAR8**            cname ;

**cname**            : word with a maximum length of 8 characters.

### Example

```

END DATA ;
DOUBLE      TIME        DT ;
CHAR8       CNOM ;
INTEGER     NPAS        IAU;
*
RESTORE    ;
CNOM =     'ESSAI' ;
....
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 82/851

24

## CHECK VALVE OPERATOR

The **CHECK VALVE** operator is used in the *data block* to create a **CHECK VALVE** type object. It can be of two types :

1. the **mesh wise** **CHECK VALVE** which allows the fluid to flow in the direction of the meshing,
2. the **counter mesh wise** **CHECK VALVE** which allows the fluid to flow in the opposite direction of the meshing.

The **CHECK VALVE** can be located either on a current vector mesh of an axial element, or between two elements. Junctions must be of type [AXIAL-VOLUME] or [AXIAL-TEE].

The **CHECK VALVE** operator only defines and locates the valve. To enable or disable the valve refer to the **ENABLE** and **DISABLE** directives.

### Associated Keywords

**ENABLE**, **DISABLE**, **VALUE FOR VALVE**, **WRITE FOR VALVE**

### Syntax

```
elem =      CHECK VALVE      POINT          pipe1           pvect1
           or             JUNCTION       elem1          elem2
           RO            roref
           CV            cv
           DP            deltap
           (TCVFUITE    tcvfuite)
           (TCVENCER   tcvencr)      ;
```

<b>elem</b>	: name of the check valve
<b>POINT</b>	: keyword indicating that the valve is located on an internal mesh of an axial element. It is followed by
<b>pipe1</b>	: name of the pipe
<b>pvect1</b>	: name of the vector point where the <b>CHECK VALVE</b> is located.
<b>JUNCTION</b>	: keyword indicating that the <b>CHECK VALVE</b> is located at a junction between a volume or a tee and an axial.
<b>elem1</b>	: name of the volume or the tee

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 83/ <a href="#">851</a>

<b>elem2</b>	: name of the pipe
<b>RO roref</b>	: keyword followed by a real roref > 0. Roref is the reference fluid density for the valve specifications (kg/m <sup>3</sup> ) - If roref ≤ 500 kg/m <sup>3</sup> , the capacity is supposed to be defined in critical steam flow condition - If roref > 500 kg/m <sup>3</sup> , the capacity is supposed to be defined in sub-critical liquid flow condition
<b>CV cv</b>	: keyword followed by a real > 0. CV is the valve capacity when the valve is fully open.
<b>DP deltap</b>	: keyword followed by a real. deltap is the step of pressure to have the valve fully open. (Pa)
<b>TCVFUITE tcvfuite</b>	: OPTIONAL keyword followed by a real = 0 and = 1. tcvfuite is the normalised CV for maximum leakage according to CV <sub>max</sub> . Default value is 1.
<b>TCVENCER tcvencr</b>	: OPTIONAL keyword followed by a real = 0 and = 1. tcvencr is the coefficient of proportionality of current CV for maximum fouling. Default value is 1.

NB: The sign of deltap defines the type of the CHECK VALVE :

1. In case of PIPE :
  - (a) If deltap > 0 the valve will be a mesh-wise CHECK VALVE.
  - (b) If deltap < 0 the valve will be a counter-mesh-wise CHECK VALVE.
2. In case of JUNCTION :
  - (a) If deltap > 0 the flow will be enabled from elem1 to elem2.
  - (b) If deltap < 0 the flow will be enabled from elem2 to elem1.

### Examples

1)  
 pvp1=           VECTOR           tuyvap1           42.9 ;  
 vpi1=           CHECK VALVE     POINT           tuyvap1        pvp1  
                                     RO                  1.  
                                     CV                  5674.  
                                     DP                  0.1D+5        ;

2)  
 vpi2=           CHECK VALVE     JUNCTION        Vol1           Tuyvap1  
                                     RO                  1.  
                                     CV                  5674.  
                                     DP                  -0.1D+5        ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 84/ <a href="#">851</a>

3)

```
pvp1 = VECTOR tuyvap1 42.9 ;
vpi1 = CHECK VALVE POINT tuyvap1 pvp1
RO 1.
CV 5674.
DP 0.1D+5
TCVFUITE 0.3D0 ;
```

4)

```
vpi2 = CHECK VALVE JUNCTION teaccu1 Dechac1
RO 990.
CV 5674.
DP -0.1D+5
TCVENCNR 0.8D0 ;
```

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 85/ <a href="#">851</a>

25

## CIRCUIT OPERATOR

The **CIRCUIT** operator, *in data block*, creates a circuit from a list of components.

*Remark for the CATHARE2 V2.5 version series :*

1. The TEE is linked to an axial element, so it should not be declared in the list of elements in the CIRCUIT operator.
2. The CORE object must appear in the definition of a primary circuit if this circuit uses it (see CORE operator).

### Associated Keywords

REACTOR, CORE, RADCHEMI, NONCOND, FLUID, MONOPHAS(E), MODGRAV, VALBA FOR CIRCUIT, VALUE FOR A CIRCUIT

### Syntax

circn =	<b>CIRCUIT</b>	elem1	<b>(GROUP)</b>	elem2	<b>(GROUP)</b>	elem3
	<b>(GROUP)...</b>	elemn				
	(core1)	(noncox)	(radchem)	(fluidnam)	(ELEV z1);	

<b>elem1 ... elemn</b>	: The circuit is built up of elements. During the computation, the element printouts will appear following the order in which the elements were listed in the circuit operator. WARNING : each element should appear only once in the list. Some elements can be of type <b>GROUP</b> . In that case, each of them must be followed by the keyword <b>GROUP</b>
<b>core1</b>	: OPTIONAL core object defining the core component in the primary circuit (see CORE operator)
<b>noncox</b>	: OPTIONAL noncond object defining the non-condensable gases transported in the circuit hydraulics (see NONCOND operator).
<b>radchem</b>	: OPTIONAL radio-chemical object defining the component transported in the circuit hydraulics (see RADCHEMI operator).
<b>fluidnam</b>	: OPTIONAL fluid object defining the main fluid transported in the circuit hydraulics (see FLUID operator). Default is light water (keyword WATER) as used for coolant in french PWRs.

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 86/ <a href="#">851</a>

**ELEV z1** : OPTIONAL keyword followed by a real which defines the elevation of the circuit (i.e. the elevation of the first junction of the circuit) with respect to a position defined by the user (usually corresponding to the bottom of the containment).

Example
---------

```

1)
core1 =      CORE          PO          2.8305D9
              ....
              LIFETIME    35.0D-6   ;
circ1 =      CIRCUIT       input1     pipe1      volume1    exit1      core1
              ELEV         9.D0 ;              

2)
fluid1 =     WATER ;      input1     pipe1      volume1    exit1      fluid1
cic2 =      CIRCUIT       input1     pipe1      volume1    exit1
              ELEV         9.D0 ;              

3)
noncond1 =   NONCOND       1          HYDROGEN;
radchem1 =   RADCHEMI      2          BORON      AZOTE16;
Circ3 =      CIRCUIT       input1     pipe1      cana       volume1    exit1
              noncond1    radchem1  ELEV        27.D0 ;              

4)
cana =       AXIAL         GROUP      TEMPLATE   pipe1
              bota          USTREAM   topa       DSTREAM ;
circ4 =      CIRCUIT       input1     pipe1      cana
              GROUP         volume1   exit1     noncond1  radchem1
              ELEV         27.D0 ;               
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 87/851

26

## CLOSE DIRECTIVE

The **CLOSE** directive is used in *command block* to disable the thermal hydraulic calculation for an ACCU. The other gadgets are disabled by the DISABLE directive.

### Associated Keywords

OPEN, ACCU

### Syntax

**CLOSE**      item

**item** : name of the gadget to disconnect. It can be of the following type :  
 ACCU

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is FERMER : CALL FERMER ( OBJDIR, CTYPE, 0, 0, CVAL, IVAL, RVAL, \*9999)

OBJDIR	CHARACTER*8 name of the object to disconnect
CTYPE, CVAL	CHARACTER*8 can take any value for it is not used
IVAL	integer can take any value for it is not used
RVAL	real can take any value for it is not used

DE LA RECHERCHE À L'INDUSTRIE <b>cea</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 88/851

27

## CLOSEGAP DIRECTIVE

The **CLOSEGAP** directive, *in command block*, enables the user to keep the initial value ( $t=0s$ ) of the gap conductance during the whole transient calculation, for any axial mesh for which the cladding is in contact with the pellet at  $t=0$ . It becomes effective when called and must be called before the beginning of the transient calculation.

### Associated Keywords

FUELCHAR

### Syntax

**CLOSEGAP** fuelchar1 ;

**fuelchar1** : name of the fuelchar element for which the initial gap conductance must be kept during transient

### Example

**CLOSEGAP** CARMOY ;

**NB1** : This directive can not be used when the GAPCOND CCV of a FUEL WALL is written.

**NB2** : the FORTRAN subroutine called in PILOT is CLOSEGAP : CALL CLOSEGAP ( OBJNAM, \*9999)

OBJNAM CHARACTER\*8 name of the fuelchar for which the fuel properties must be adjusted.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 89/851

28

## COMETE DIRECTIVE

The **COMETE** directive is used, in the *command block*, in order to identify whether a calculation is made with COMETE coupling or not.

**N.B.** Because it modifies the file PILOT.f, the **COMETE** directive must be placed in the first line of *command block*.

### Associated Keywords

**HYDRCOM, HYDRMOD, WALLCOM, WALLMOD, TOURNANT**

### Syntax

**COMETE      (KELVIN)      (COSIMU      iparam)      ;**

**(KELVIN)** : optional keyword indicating that the temperatures will be computed in °K instead of °C.

**(COSIMU iparam)** : optional keyword followed by an integer parameter indicating the level of coupling calculation.

 <b>ce</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 90/851

29

## COMPHYD DIRECTIVE

The **COMPHYD** directive, used in *command block*, concatenates several hydraulic files, created by the **STOREHYD** directive, into a single one (see **CATAFUEL** option 2).

### Associated Keywords

**CATAFUEL**, **HYDIMP**, **HYDMOD**, **READHCAT**, **READHEXT**, **STDYFUEL**, **TRANFUEL**

### Syntax

#### Syntax 1

```
COMPHYD ifile1 ... ifilen
      IN           ifileout ;
```

<b>ifile1 ... ifilen</b>	: logical unit number of files to concatenate. In this case the file names are the default names of FORTRAN (i.e. FORTnn on HP-UX where nn is the logical unit number of the file)
<b>IN</b>	: keyword indicating that the logical unit number of the output file follows.
<b>ifileout</b>	: logical unit number of the resulting file.

#### Syntax 2

```
COMPHYD n           FORMAT
          or
          BINARY     file1 ... filen
          OUTPUT    fileout ;
```

<b>n</b>	: integer > 1, representing the number of files to concatenate.
<b>FORMAT</b>	: keyword indicating that the files are FORMATTED files.
<b>BINARY</b>	: keyword indicating that the files are BINARY files.
<b>file1 ... filen</b>	: names of the files to concatenate.
<b>OUTPUT</b>	: keyword indicating that the name of the output file follows.
<b>fileout</b>	: name of the resulting file.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 91/ <a href="#">851</a>

30

## COMPONEN(T) OPERATOR

The **COMPONEN(T)** operator, used in *data block* only, enables the user to define technical data describing specific hydraulic and thermal components like fuel assemblies and heat exchangers. These data will be used to calculate wall friction and/or forced convection heat transfer coefficients with specific correlations, which are not those used by the standard revision 6.1 of **CATHARE**. The **COMPONEN(T)** must be **ASSIGNED** to an AXIAL module to be taken into account (see **ASSIGN** directive for AXIAL modules) specifying which law (wall FRICTION or wall convection EXCHANGE coefficient) should be used.

The different types of components are:

1. the tube side of a heat exchanger : the standard correlations of **CATHARE2** rev 6.1 are used for the computation of the wall friction and the convective heat transfer coefficient.
2. the shell side of a heat exchanger : modified correlations are available for the computation of the wall friction and/or the convective heat transfer coefficient. The choice of the laws is done by the **ASSIGN** directive.
3. the finned side(s) of a heat exchanger (PLATE and FINNED) : modified correlations are available for the computation of the wall friction and/or the convective heat transfer coefficient. The choice of the laws is done by the **ASSIGN** directive.
4. the bundle side of a helicoid tube bundle heat exchanger : modified correlations are available for the computation of the wall friction and/or the convective heat transfer coefficient. The choice of the laws is done by the **ASSIGN** directive.
5. both sides of a Printed Circuit Heat eXchanger: modified correlations are available for the computation of the wall friction and/or the convective heat transfer coefficient. The choice of the laws is done by the **ASSIGN** directive.
6. the plate-type hydraulic core: modified correlations are available for the computation of the wall friction coefficient only.
7. the pinned-type hydraulic core
8. user correlations
9. the leak-before-break (LBB) axial element (used only with LBB application geometry): modified correlations are available for the computation of the wall friction coefficient only ; the correlations take into account friction, but also turns and flow cross area change.

The wall friction correlations do not take into account pressure drops due to inlet and outlet structures or internal structures which are considered as singular pressure drops. They must be imposed via the **SINGULAR** directive.

The user must be aware that the modified correlations for forced convection heat transfer coefficients are mainly validated under single-phase flow conditions, either liquid phase or gas phase conditions, which are those of operating and accidental transient conditions in a Gas Cooled Reactor.

There are as many syntax as there are different types of components. The hydraulic (of **AXIAL** type) and its thermal elements (**WALL**, **FUELCHAR**, **FUELPLAQ** or Heat **EXCHANGER**) must have been previously defined in the *data*

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 92/851

block of the input deck. The hydraulic data (flow section, hydraulic diameter) must be coherent with the geometry set in the **COMPONENT**.

The maximum number of components is 10.

#### Associated Keywords

**ASSIGN, AXIAL, EXCHANGER, WALL**

#### Syntax

## 30.1 Shell side of the heat exchanger

Composant =	<b>COMPONENT</b> (T)	<b>SHELL</b>	
	<b>CORFACTP</b>	vcorfactp	<b>CORFACT</b>
	<b>TUBEDIAM</b>	vtubediam	<b>PITCH</b>
	<b>FLOWSECT</b>	vflowsect	
	<b>DESIGN</b>		<b>SQR90</b>
		or	<b>TRI30</b>
		or	<b>SQR45;</b>

Composant	: name of the COMPONENT which will be used in the ASSIGN directive
<b>COMPONENT</b> (T)	: keyword followed by
<b>SHELL</b>	: keyword for the shell side of a heat exchanger, which must be followed by :
<b>CORFACTP</b>	: corrective factor for the wall friction coefficient, depending on the tube numbers and windows of the component.
vcorfactp	
<b>CORFACT</b>	: corrective factor for the reference heat transfer coefficient (in the range 0.6-1)
vcorfact	
<b>TUBEDIAM</b>	: tube diameter of the tubes of the bundle
vtubediam	
<b>PITCH</b>	: pitch of the tube bundle
vpitch	
<b>FLOWSECT</b>	: flow section for one channel, used for the definition of the Reynolds number. It is equal to the global flow section of the component divided by the hydraulic weight of the hydraulic component it will be assigned to.
vflowsect	
<b>DESIGN</b>	: pitch type and orientation with respect to the flow ,
<b>SQR90</b>	square, 90°
or <b>SQR45</b>	square, 45°
or <b>TRI30</b>	triangular, 30°



Composant = **COMPONENT**(*T*)                           **SHELLNA**  
**HYDRPERIM**    vhyd                           **CORFACT**                            vcorfact ;

**Composant** : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**SHELLNA** : keyword for the shell side of a heat exchanger, which must be followed by :  
**HYDRPERIM** : hydraulic perimeter of the shell side of the heat exchanger  
**vhyd**

**CORFACT** : correction factor for the heat transfer coefficient  
vcorfact

Composant = **COMPONEN(T)**                                   **SGSPX** ;

**Composant** : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONENT** : keyword followed by  
**SGSPX** : keyword for the shell side of SPX sodium / water heat exchanger

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 94/ <a href="#">851</a>

## 30.2 Finned side of a heat exchanger

Composant =      **COMPONENT**(T)                  **FINNED**                  **PLATE**  
**PITCH**              vpitch                  **HEIGHT**              vheight  
**THICK**              vthick                  **OFFSET**              voffset ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONENT**(T) : keyword followed by  
**FINNED PLATE** : keyword for the plate finned side of a heat exchanger, which must be followed by :  
**PITCH** : pitch of the cooling fins  
vpitch

**HEIGHT** : height of the cooling fins  
vheight

**THICK** : thickness of the cooling fins  
vthick

**OFFSET** : offset length of the cooling fins. Set to 0 to indicate there is no offset.  
voffset

Composant =      **COMPONENT**(T)                  **FINNEDNA**                  **PLATE**  
**PITCH**              vpitch                  **HEIGHT**              vheight  
**THICK**              vthick                  **OFFSET**              voffset  
**CORFACT**            vcorfact                  ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONENT**(T) : keyword followed by  
**FINNEDNA** : keyword for the plate finned side of a heat exchanger, which must be followed by :  
**PLATE**  
**PITCH** : pitch of the cooling fins  
vpitch

**HEIGHT** : height of the cooling fins  
vheight

**THICK** : thick of the cooling fins  
vthick

**OFFSET** : offset length of the cooling fins. Set to 0 to indicate there is no offset.  
voffset

**CORFACT** : correction factor for the heat transfer coefficient  
vcorf

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 95/ <a href="#">851</a>

### 30.3 Side of a Printed Circuit Heat exchanger

Composant =      **COMPONEN(T)**                          **PCHX**  
**RAY**                        vray                          **THICK**                        vthick  
**DESIGN**                    **STRAIGHT**  
or                            **WAVY**  
or                            **USER** value                    ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PCHX** : keyword for the printed circuit heat exchanger, which must be followed by :  
**RAY** : radius of the channel  
vray

**THICK** : equivalent thickness of the channel  
vthick

**DESIGN** : keyword indicating the **type of CHANNEL**  
**STRAIGHT** : keyword indicating whether the channel are straight  
**or WAVY** or wavy  
**or USER** or of user type. In that case, the keyword is followed by a real number defining the laminar value to be used for the Nusselt number.

### 30.4 Bundle side of a helicoid tube bundle heat exchanger

Composant =      **COMPONEN(T)**                          **HELICOID**                        ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**HELICOID** : keyword for a helicoid tube bundle heat exchanger

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 96/ <a href="#">851</a>

## 30.5 Plate type hydraulic core

Composant =      **COMPONEN(T)**                          **PLANGEOM** ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PLANGEOM** : keyword for a plate type hydraulic core  
No modified convective heat transfer coefficient is available.

Composant =      **COMPONEN(T)**                          **PLATGEOM**  
**LENGTH**        a    **WIDTH**        b;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PLATGEOM** : keyword for a rectangular channel hydraulic core  
**LENGTH a** : length of the channel (use 0, if infinite channel)  
**WIDTH b** : width of the channel

## 30.6 Pin type hydraulic core

Composant =      **COMPONEN(T)**                          **PINGEOM**  
**PITCH**           vpitch                                    **PINDIAM**       Pindiam ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PINGEOM** : keyword for a pin type hydraulic core  
**PITCH vpitch** : pitch of the pin  
**PINDIAM** : diameter of the pin  
**vpindiam**

Composant =      **COMPONEN(T)**                          **PINWIRE**  
**PITCH**           vpitch                                    **PINDIAM**       Pindiam  
**WIREDIAM**       wdiam                                    **HEIGHT**       h ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PINWIRE** : keyword for a pin with wire type hydraulic core

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 97/ <a href="#">851</a>

**PITCH vpitch** : pitch of the pin  
**PINDIAM** : diameter of the pin  
**vpindiam**  
**WIREDIAM wdiam** : diameter of the wire  
**HEIGHT h** : pitch of the wire

Composant =      **COMPONEN(T)**                            **PINGEONA**  
**PINDIAM**        pindiam                            **PINPITCH**        vpitch  
**WIRPITCH**        wpitch                            **RUGOSITY**        vrugos  
**CORFACT**        vcorf                                ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive  
**COMPONEN(T)** : keyword followed by  
**PINGEONA** : keyword for a pin type hydraulic core (sodium reactor)  
**PINDIAM** pindiam : diameter of the pin  
**PINPITCH** vpitch : pitch of the pin  
**WIREPITCH** : pitch of the wire  
 wpitch  
**RUGOSITY** vrugos : rugosity of the pin  
**CORFACT** vcorf : correction factor for the heat transfer coefficient

Composant =      **COMPONEN(T)**                            **PINWIRNA**  
**PINDIAM**        pindiam                            **PINPITCH**        vpitch  
**WIRPITCH**        wdiam                            **WIRPITCH**        wpitch  
**PRATIO**         rperim                                ;

Composant : name of the COMPONENT which will be used in the ASSIGN directive to activate  
 the specific friction correlation applied to pin with wire  
**COMPONEN(T)** : keyword followed by  
**PINWIRNA** : keyword for a pin type hydraulic core (sodium reactor)  
**PINDIAM** pindiam : diameter of the pin  
**PINPITCH** vpitch : pitch of the pin  
**WIREDIAM** : diameter of the wire  
 wdiam  
**WIREPITCH** : pitch of the wire  
 wpitch  
**PRATIO** rperim : ratio of pins perimeter to entire perimeter (pins perimeter plus hexagonal tube perime-  
 ter)

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 98/851

## 30.7 User correlations

Composant =	<b>COMPONEN(T)</b>	<b>FRICLAW</b>
	<b>FRLAM</b>	Fr0
	<b>FRTUR1</b>	a
	<b>FRDHY</b>	Dh

Composant	: name of the COMPONENT which will be used in the ASSIGN directive
<b>COMPONEN(T)</b>	: keyword followed by
<b>FRICLAW</b>	: keyword for a user forced convection friction law
<b>FRLAM</b> Fr0	: for laminar flow, friction coefficient is equal to : $f = \frac{Fr0}{Re}$
<b>FRTUR1</b> a	: for turbulent flow, friction coefficient is equal to : $f = \frac{Fr0}{Re_t}$ and $Re_t = \frac{a}{Re^b}$
<b>FRTUR2</b> b	
<b>FRDHY</b> Dh	: hydraulic diameter to be used for Reynolds number computation

Composant =	<b>COMPONEN(T)</b>	<b>EXCHLAW</b>
	<b>NULAM</b>	Nu0
	<b>NUTUR1</b>	a
	<b>NUTUR3</b>	c
	<b>NUTUR5</b>	e
	<b>NUDHY</b>	Dh
		;

Composant	: name of the COMPONENT which will be used in the ASSIGN directive
<b>COMPONEN(T)</b>	: keyword followed by
<b>EXCHLAW</b>	: keyword for a user forced convection heat transfer correlation
<b>NULAM</b> Nu0	: for laminar flow, Nusselt number is equal to : $Nu = Nu_0$
<b>NUTUR1</b> a	: for turbulent flow, Nusselt number is equal to :
<b>NUTUR2</b> b	$Nu = a \cdot (Re^b + c) \cdot Pr^d (1 + e \cdot Re^f)^{0.1}$
<b>NUTUR3</b> c	
<b>NUTUR4</b> d	
<b>NUTUR5</b> e	
<b>NUTUR6</b> f	
<b>NUDHY</b> Dh	: hydraulic diameter to be used for Reynolds number computation

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 99/851

## 30.8 The leak-before-break (LBB) axial element

To use this component, it is necessary to have defined geometry of the axial element with LBB keyword (see GEOM directive).

Composant =	<b>COMPONEN(T)</b>	<b>FRILBB</b>
	<b>LBBCOREL</b> icorel	
	<b>LBBRGL</b> rgl	<b>LBBRLOC</b> rloc
	<b>LBBNT</b> Nt	
	<b>LBBR1</b> R1	<b>LBBR2</b> R2
	<b>LBBA</b> a	<b>LBBB</b> b
	<b>LBBKLAM</b> Klam	;

Composant	: name of the COMPONENT which will be used in the ASSIGN directive
<b>COMPONEN(T)</b>	: keyword followed by
<b>FRILBB</b>	: keyword for a friction law taking into account turns and flow cross area change in case of rugosity/ tortuosity
<b>LBBCOREL</b> icorel	Keyword followed by a number for friction law alone (= without rugosity/ tortuosity) : 1 for laminar flow correlation $f = \frac{Kl_{am}}{Re}$ 2 for turbulent flow Blasius correlation $f = \frac{0.079}{Re^{0.25}}$ 3 for turbulent flow correlation $f = (a \cdot \log(\frac{\delta}{Re_{ff}}) - b)^2$ 4 = max (1,2,3) correlation
<b>LBBRGL</b> rgl	: keyword followed by the peak-to-through amplitude of the global roughness contours for saw tooth geometry (m)
<b>LBBRLOC</b> rloc	: keyword followed by the local roughness (m)
<b>LBBNT</b> Nt	: keyword followed by the total number of turns per length unit ( $m^{-1}$ )
<b>LBBR1</b> R1	: keyword followed by the lower criteria for effective parameter calculation
<b>LBBR2</b> R2	: keyword followed by the upper criteria for effective parameter calculation
<b>LBBA</b> a	: keyword followed by the first constant for turbulent flow friction factor formula $f = (a \cdot \log(\frac{\delta}{Re_{ff}}) - b)^2$
<b>LBBA</b> b	: keyword followed by the second constant for turbulent flow friction factor formula $f = (a \cdot \log(\frac{\delta}{Re_{ff}}) - b)^2$
<b>LBBKLAM</b> Klam	: keyword followed by the constant for laminar flow friction factor formula $f = \frac{Kl_{am}}{Re}$

### Examples

```

PIPE1 = AXIAL ...;
IPIPE1 = AXIAL ...;
SHELRCF = COMPONENT SHELL CORFACTP 1.0 CORFACT 0.62 TUBEDIAM 0.0127D0
PITCH 0.01588D0 FLOWSECT 20013.D-6 DESIGN SQR90 ;
TUBERCF = COMPONENT TUBE ;
FINIHX = COMPONENT FINNED PLATE PITCH 0.3
HEIGHT 0.8 THICK 0.1 OFFSET 1. ;
FINIHXD = COMPONENT FINNED PLATE PITCH 0.1
HEIGHT 0.2 THICK 0.1 OFFSET 0. ;
PCHXRCF = COMPONENT PCHX RAY 1.D-2 THICK 1.D-3 DESIGN ;

```

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 100/851

HELICRCF = COMPONENT HELICOID ;

COEURPLA = COMPONENT PLANGEOM ;

COEURAIG = COMPONENT PINGEOM ;

COMPELL = COMPONENT FRILBB LBBCOREL 1 LBBRGL 19.D-6 LBBRLOC 3.D-6 LBBNT 9.D3 LBBR1 0.1D0 LBBR2 5.D0 LBBA 2.25D0 LBBB .573D0 LBBKLM 20.D0 ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 101/851

# 31

## CONNECT DIRECTIVE

The CONNECT directive is used, *in the data block*, to define the connection of a TEE gadget or of a THREED element with other elements.

### 31.1 CONNECT for a TEE

The CONNECTdirective is used to connect a TEE-BRANCH to an AXIAL element.

It replaces the old keyword “LINK”. The CONNECT directive deals with the port name associated with the tee.

#### Associated Keywords

TEE, AXIAL, THREED, GEOM, SINGULAR

#### Syntax

```
CONNECT      axial_name      port-tee_name           scalar_point;
```

axial_name	: axial element supporting the tee branch
port-tee_name	: port of the tee to be connected (port = tee junction)
scalar_point	: scalar point of the axial element defining the axial location of the tee

#### Example

```
TEPRESSU      = TEE          tepexp        DSTREAM ;
GENVAPR       = AXIAL        suprompu     USTREAM      downromp      DSTREAM      WEIGHT 1;
ptpres        = SCALAR       GENVAPR      1.444 ;
CONNECT        GENVAPR       tepexp        ptres ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 102/851

## 31.2 CONNECT for a THREED

The **CONNECT** operator is **compulsory** in the definition of a **THREED (3D)** module and must appear in the *data block*. It defines

1. the connections between the element 3D hydraulic meshing and the other elements of the circuit.
2. The flow domain

**NB :**

1. It must be used after the **MESH** operator.
2. For all the information about numbering, please refer to the user manual pages named “NUMBERING in THREED elements”.
3. **BEWARE** that because of the initialization algorithm, if a no-flow closed domain is defined, each mesh face of the domain has to be individually closed.

### Associated Keywords

**THREED, GEOM, HYDR, MESH, PHYSCALE, SINGULAR, GODIFF, GOTURB, TPERTR, TURBULEN,**

### Syntax

```

CONNECT threed_name
  EXTERNAL BOUNDARY junction_name snode
    nint
    (VALUE
     SECT sect1      PERI       perim1      (DETAZ       deltaz1)
     HYDR nj
     SINGULAR POSITIVE zp
                  NEGATIVE zm )
  or
  EXTERNAL BOUNDARY junction_name vnode
    inode      inode+1   jnode        jnode+1   knode      knode+1
    (VALUE
     SECT sect1      PERI       perim1      (DETAZ       deltaz1)
     HYDR nj
     SINGULAR POSITIVE zp
                  NEGATIVE zm )
  or
  INTERNAL BOUNDARY junction_name snode
    nint
    (WEIGHT iweight)
    (VALUE
     OPEN or          CLOSED
     optio sect1      PERI       perim1      (DETAZ       deltaz1)
     HYDR nj
     SINGULAR POSITIVE zp
                  NEGATIVE zm)

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 103/851

or

<b>INTERNAL</b>	<b>BOUNDARY</b>			
inode	inode+1	junction_name	vnode	
( <b>WEIGHT</b> ( <b>VALUE</b>	iweight)	jnode	jnode+1	
<b>OPEN</b>	or	<b>CLOSED</b>		
<b>SECT</b>	sect1	<b>PERI</b>	perim1	( <b>DELTAZ</b>
<b>HYDR</b>	nj			deltaz1)
<b>SINGULAR</b>	<b>POSITIVE</b>	zp		
	<b>NEGATIVE</b>	zm)		

**EDGETYPE AUTO**

and/or

<b>XEDGE</b>	(or	<b>TETAEDGE</b> )	<b>DEFAULT</b>	<b>OPEN/CLOSED</b>
		or	AUTO	

<b>SEGMENT</b>	<td style="width: 20%;"></td> <td style="width: 20%;"></td>			
	VALUE			
	<b>OPEN/CLOSED</b>			

or  
**LISTPOINT** npt  
VALUE  
OPEN/CLOSED

or  
i1 i2 ... inpt

or  
**FXZONE** vx\_zone\_name

(or  
ibeg iend  
jbeg jend  
kbeg kend)

**OPEN/CLOSED**

To be repeated as many times as needed

<b>YEDGE</b>	(or	<b>TETAEDGE</b> )	<b>DEFAULT</b>	<b>OPEN/CLOSED</b>
		or	AUTO	

and/or

<b>SEGMENT</b>	<td style="width: 20%;"></td> <td style="width: 20%;"></td>			
	VALUE			
	<b>OPEN/CLOSED</b>			

To be repeated as many times as needed

or  
**LISTPOINT** npt

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 104/851

<b>VALUE</b> <b>OPEN/CLOSED</b> i1 i2 ... inpt or <b>FXZONE</b> vy_zone_name (or ibeg iend jbeg jend kbeg kend) <b>OPEN/CLOSED</b>	<b>ZEDGE</b> or and/or	<b>DEFAULT</b> <b>AUTO</b> <b>OPEN/CLOSED</b>	
<b>SEGMENT</b> begt endpt <b>VALUE</b> <b>OPEN/CLOSED</b> or <b>LISTPOINT</b> npt <b>VALUE</b> <b>OPEN/CLOSED</b> i1 i2 ... inpt or <b>FXZONE</b> vx_zone_name (or ibeg iend jbeg jend kbeg kend) <b>OPEN/CLOSED</b>			
<b>To be repeated as many times as needed</b>			
<b>CONNECT</b> : keyword indicating the beginning of the CONNECT directive for the threed_name “threed” object type.			
<b>threed_name</b>			
<b>EXTERNAL</b> : keywords to introduce the specifications of the external boundary condition nodes defined in the THREED directive. It must be repeated for each external junction. External junctions are designed for junctions with outer mesh cell faces.			
<b>BOUNDARY</b>			
<b>INTERNAL</b> : keywords to introduce the specifications of the internal boundary condition nodes defined in the THREED directive. It must be repeated for each internal junction. Internal junctions are designed for junctions with internal mesh cell faces.			
<b>BOUNDARY</b>			
<b>junction_name</b> : name of the junction to be connected with the mesh.			
<b>junction_name</b>			

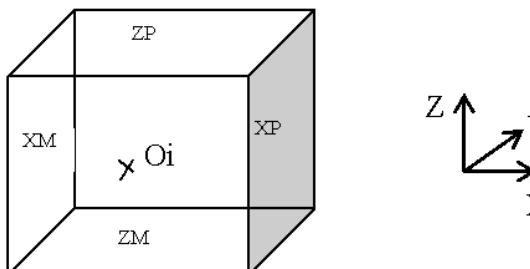
<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr style="width: 100%; border: 0; border-top: 1px solid green; margin: 5px 0;"/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 105/851

**Defining the localization of the junction in the element means to give the value of a scalar node (to locate a mesh) and an orientation (to locate a face). Two ways are possible :**

### 1. Using scalar meshes numbering

**snode** : keyword which defines the mesh cell face where the junction is connected. It must take one of the following values :

<b>XM</b> or <b>XP</b> or <b>YM</b> or <b>YP</b> or <b>ZM</b> or <b>ZP</b>	rectangular CATHARE coordinates (see drawing below) the junction is connected on the mesh cell $x^-$ face X direction, the junction is connected on the mesh cell $x^+$ face X direction, the junction is connected on the mesh cell $y^-$ face Y direction, the junction is connected on the mesh cell $y^+$ face Y direction, the junction is connected on the mesh cell $z^-$ face Z direction, the junction is connected on the mesh cell $z^+$ face Z direction,
or <b>TETAM</b> or <b>TETAP</b> or <b>RM</b> or <b>RP</b> or <b>ZM</b> or <b>ZP</b>	cylindrical CATHARE coordinates the junction is connected on the mesh cell $\Theta^-$ face TETA direction, the junction is connected on the mesh cell $\Theta^+$ face TETA direction, the junction is connected on the mesh cell $r^-$ face R direction, the junction is connected on the mesh cell $r^+$ face R direction, the junction is connected on the mesh cell $z^-$ face Z direction, the junction is connected on the mesh cell $z^+$ face Z direction



Oi : scalar node – mesh cell number

Figure 31.2.1: CONNECT : A 3D cell

For a mesh cell and a given coordinate there are two faces. One with the lower value of the coordinate ( $x^-, y^-, z^-$  or  $\Theta^-, r^-, z^-$ ) and one with the higher value of the coordinate ( $x^+, y^+, z^+$  or  $\Theta^+, r^+, z^+$ )

**nint** : Integer defining the mesh cell number (scalar node number, Oi in the drawing above)

### 2. Using per axis numbering / zone definition

**vnode** : The keyword vnode indicates the mesh cell face where the junction is connected. It must take one of the following values :

<b>AXM</b>	rectangular CATHARE coordinates the junction is connected on the mesh cell $x^-$ face X direction,
------------	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 106/851

or <b>AXP</b>	the junction is connected on the mesh cell $x^+$ face X direction,
or <b>AYM</b>	the junction is connected on the mesh cell $y^-$ face Y direction,
or <b>AYP</b>	the junction is connected on the mesh cell $y^+$ face Y direction,
or <b>AZM</b>	the junction is connected on the mesh cell $z^-$ face Z direction,
or <b>AZP</b>	the junction is connected on the mesh cell $z^+$ face Z direction, cylindrical <b>CATHARE</b> coordinates
<b>ATETAM</b>	the junction is connected on the mesh cell $\Theta^-$ face TETA direction,
<b>ATETAP</b>	the junction is connected on the mesh cell $\Theta^+$ face TETA direction,
<b>ARM</b>	the junction is connected on the mesh cell $r^-$ face R direction,
<b>ARP</b>	the junction is connected on the mesh cell $r^+$ face R direction,
<b>AZM</b>	the junction is connected on the mesh cell $z^-$ face Z direction,
<b>AZP</b>	the junction is connected on the mesh cell $z^+$ face Z direction
<b>inod inod+1</b>	: 6 Integers defining a scalar node using the velocities plane numbering (see definition of a scalar zone with one single scalar point)
<b>jnod jnod+1</b>	
<b>knod knod+1</b>	
<b>WEIGHT iweight</b>	: OPTIONAL keyword followed by an integer $> 0$ , defining the weight of the junction. The weight of the junction refers to the number of elements of the same type connected to the junction. The default value is 1.
<b>VALUE</b>	: keyword indicating that the geometrical data at the junction will be defined. It is MANDATORY only for an <u>internal</u> junction. If this keyword is omitted (for an external junction), the junction has the geometrical data of the mesh cell face it is connected to.
<b>CLOSED</b> or	: keyword indicating that the standard vector node facing the junction is closed (i.e. not connected with its 3D neighbours). <b>INTERNAL junction only</b>
<b>OPEN</b>	: keyword indicating that the standard vector node facing the junction remains open (i.e. connected with its 3D neighbours). <b>INTERNAL junction only</b>
<b>SECT sect</b>	: keyword followed by a real number $> 0$ . defining the flow section ( $m^2$ ).
<b>PERI peri</b>	: keyword followed by a real number $> 0$ . defining the friction perimeter (m).
<b>DELTAZ deltazl</b>	: OPTIONAL keyword followed by a real number $> 0$ , defining the integration length (m) into the THREED element used in the momentum equation at the junction. The default integration length is the half-size of the THREED mesh cell associated to the other junction. It should be adjusted if the meshes on side of the junction are very different in size.
<b>HYDR nj</b>	: keyword followed by an integer nj defining the flow geometry (0 for standard flow, 1 for rod bundle flow, 2 for annular flow) This value is not used (refer to remark paragraph below)

	<p style="margin: 0;">DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
<b>Document technique DEN</b>	Page 107/851

<b>SINGULAR</b>	: keyword used to introduce the values of friction coefficient in the direction of positive velocities or in the direction of negative velocities. <b>Remark :</b> When the THREED element is connected to an AXIAL or a BCONDIT (type BLIND or SAFETYVA) the junction momentum equations are not written by the THREED element but by the adjacent element. As a consequence, singular pressure drop should not be defined on this kind of junction in the 3D element but in the adjacent one. 
<b>POSITIVE zp</b>	It is mandatory to put zm and zp values to 0.D0 in this case : keyword followed by a real number defining the friction coefficient in the direction of positive velocities. Positive means that the fluid flows according to the meshing orientation
<b>NEGATIVE zm</b>	: keyword followed by a real number defining the friction coefficient in the direction of negative velocities. Negative means that the fluid flows in the reverse direction according to the meshing orientation.
<b>EDGETYPE</b>	: keyword to introduce the type of the mesh faces. All the internal and external junctions must be defined before using EDGETYPE. It is followed by :
<b>AUTO</b>	: OPTIONAL keyword that closes all the outer faces of the ‘threed_name’ element and opens all the internal faces and the junction faces. When this optional keyword is used, all the following keywords are optional.
<b>XEDGE (or TETAEDGE)</b>	: keyword to introduce the VX face OPEN/CLOSED status.
<b>YEDGE (or REDGE)</b>	: keyword to introduce the VY face OPEN/CLOSED status.
<b>ZEDGE</b>	: keyword to introduce the VZ face OPEN/CLOSED status.
<b>AUTO</b>	They are all followed by : keyword indicating that all the defined type outer faces are closed and the internal faces are open automatically. This option is not compatible with the DEFAULT option in the same direction. If it is used, it must be at first.
<b>DEFAULT</b>	: keyword indicating that all the defined type faces have the same status. This option is not compatible with the AUTO option in the same direction. If it is used, it must be at first. It is followed by :
<b>OPEN or CLOSED or SYMAXE</b>	: keywords to indicate that all the considered faces are open or closed. : in Z axis direction in case of diffusion or turbulent calculation (see GODIFF or TURBULEN directive), keyword to use for the symmetry axis to cancel diffusion gradient on the symmetry axis (Z-axis)
<i>If it is necessary, this can be followed by SEGMENT, LISTPOIN and/or FXZONE (FYZONE or FZZONE), repeated as many times as needed).</i>	
<b>SEGMENT</b>	: keyword defining a continuous segment of faces from begpt to endpt where all the faces have the same status. It is followed by :
<b>begpt endpt</b>	: 2 integers defining the first and last CATHARE coordinates of the face segment (referring to vector node numbering in the selected direction).
<b>VALUE</b>	: keyword to indicate the nature of the described cell faces, open or closed.
<b>OPEN or CLOSED</b>	: keywords to indicate that all the considered faces are open or closed.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 108/851

<b>or SYMAXE</b>  <b>LISTPOIN</b>  <b>npt</b> <b>VALUE</b> <b>OPEN</b> <b>or CLOSED</b> <b>or SYMAXE</b>  <b>i1 i2</b> <b>... inpt</b> <b>FXZONE</b>  <b>vx_zone_name</b>  <b>or by</b> <b>ibeg iend</b> <b>jbeg jend</b> <b>kbeg kend</b> <b>OPEN</b> <b>or CLOSED</b>  <b>FYZONE</b>  <b>vy_zone_name</b>  <b>or by</b> <b>ibeg iend</b> <b>jbeg jend</b> <b>kbeg kend</b> <b>OPEN</b> <b>or CLOSED</b> <b>or CLOSED</b> <b>or SYMAXE</b>	: in Z axis direction in case of diffusion or turbulent calculation (see GODIFF or TURBULEN directive), keyword to use for the symmetry axis to cancel diffusion gradient on the symmetry axis (Z-axis)  : keyword to indicate that a certain number of internal faces have the same status open or closed. It is followed by: : integer, number of mesh cell faces referenced below. : keyword to indicate the nature of the described cell faces, open or closed. : keywords to indicate that all the considered faces are open or closed.  : in Z axis direction in case of diffusion or turbulent calculation (see GODIFF or TURBULEN directive), keyword to use for the symmetry axis to cancel diffusion gradient on the symmetry axis (Z-axis) : npt integers, numbers of the faces concerned by the specification (referring to vector node numbering in the selected direction) : keyword indicating that all the X vector faces of a rectangular zone have the same status open or closed. This option is only valid for X vector faces. It is followed by: : name of a zone of X vector nodes previously defined in the MESH directive for the threed_name element.  : 6 integers, velocity plane numbers which define the X vector node zone boundaries.  : keywords to indicate that all the considered faces are open or closed.  : keyword indicating that all the Y vector faces of a rectangular zone have the same status open or closed. This option is only valid for Y vector faces. It is followed by : : name of a zone of Y vector nodes previously defined in the MESH Directive for the threed_name element.  : 6 integers, velocity plane numbers which define the Y vector node zone boundaries.  : keywords to indicate that all the considered faces are open or closed.  : keyword indicating that all the Z vector faces of a rectangular zone have the same status open or closed. This option is only valid for Z vector faces. It is followed by : name of a zone of Z vector nodes previously defined in the MESH Directive for the threed_name element.  : 6 integers, velocity plane numbers which define the Z vector node zone boundaries.  : keywords to indicate that all the considered faces are open or closed.  : in Z axis direction in case of diffusion or turbulent calculation (see GODIFF or TURBULEN directive), keyword to use for the symmetry axis to cancel diffusion gradient on the symmetry axis (Z-axis)
---	---

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 109/851

**Example**

CONNECT DOWNCO3D

\* cold leg junctions

EXTERNAL BOUNDARY FRO1DOWN RP 7

EXTERNAL BOUNDARY DOWNFRO2 RP 15

EXTERNAL BOUNDARY FRO3DOWN RP 39

EXTERNAL BOUNDARY FRO4DOWN RP 47

\* bottom junctions

EXTERNAL BOUNDARY DWNVOL1 ZM 1

EXTERNAL BOUNDARY DWNVOL2 ZM 9

EXTERNAL BOUNDARY DWNVOL3 ZM 17

EXTERNAL BOUNDARY DWNVOL4 ZM 25

EXTERNAL BOUNDARY DWNVOL5 ZM 33

EXTERNAL BOUNDARY DWNVOL6 ZM 41

EXTERNAL BOUNDARY DWNVOL7 ZM 49

EXTERNAL BOUNDARY DWNVOL8 ZM 57

\* top junctions

EXTERNAL BOUNDARY DWNCOU1 ZP 8

EXTERNAL BOUNDARY DWNCOU2 ZP 16

EXTERNAL BOUNDARY DWNCOU3 ZP 24

EXTERNAL BOUNDARY DWNCOU4 ZP 32

EXTERNAL BOUNDARY DWNCOU5 ZP 40

EXTERNAL BOUNDARY DWNCOU6 ZP 48

EXTERNAL BOUNDARY DWNCOU7 ZP 56

EXTERNAL BOUNDARY DWNCOU8 ZP 64

\* - closed edges / cylindrical coordinates

EDGETYPE

TETAEDGE DEFAULT OPEN

REDGE DEFAULT CLOSED LISTPOIN 4 VALUE OPEN 71 79 103 111

ZEDGE DEFAULT OPEN ;

<b>DE LA RECHERCHE À L'INDUSTRIE</b> 	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 110/851

32

## CONTROL ROD GROUP OPERATOR

The **CONTROL ROD GROUP** operator used in the data block creates a CONTROL ROD GROUP type object. It is used to model control rods with control rod drive mechanisms involved in the group insertion, and takes into account:

1. Reactivity insertion in the core due to modification of absorber rods insertion depth, including differential thermal dilatation of both drive mechanisms and absorber rods with respect to fuel rods.
2. Reactivity feedback due to coolant density variation in the absorber rods area.

It can be used only if a core (CORE element) has been defined in the circuit and it has an effect on core reactivity only if point kinetics model computation has started (GONEUT directive).

### Associated Keywords

CORE, CONTROL ROD MECHA, GONEUT

### Syntax

elem =	<b>CONTROL</b>	<b>ROD</b>	<b>GROUP</b>	core1
	<b>TIP</b>	<b>LENGTH</b>	lentip	
		<b>TAU</b>	<b>DIAM</b>	Di
		or	<b>VALUE</b>	tcond
	<b>ROD</b>	<b>COEFT</b>	coefttip	
		<b>LENGTH</b>	lenabs	<b>COEFT</b>
		<b>COEFV</b>	coefvcool	coeftabs
				coeftcool
		<b>MECHA</b>	meca1	<b>WORTH</b>
				worth11
			<b>WEIGHT</b>	weight11
		(..)		
		<b>WORTH</b>		worth1n
		<b>WEIGHT</b>		weight1n
		(...)		
		<b>MECHA</b>	meca2	<b>WORTH</b>
				worth21
			<b>WEIGHT</b>	weight21
		(..)		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 111/851

||

**WORTH**  
**WEIGHT**

worth2p  
weight2p

<b>SCURVE</b>	<b>POLY</b>	<b>DEGREE</b>	<code>q</code>
		<b>COEF</b>	<code>co ... cq</code>
		<b>XMIN</b>	<code>insmin</code>
		<b>XMAX</b>	<code>insmax</code>
or			
<b>SHADOW</b>	<b>LAW</b>		<code>lawS</code>
<b>INSERT</b>	<code>vshadow</code>		
	<code>insini</code>		<code>;</code>

- elem** : name of the control rod group
- core1** : name of the core object for which the control rod will be taken into account
- TIP** : keyword indicating that control rod tip characteristics will be given.
- LENGTH** lentip : keyword followed by a real  $> 0$  defining the length of the control rod tip (m)
- TAU** : keyword indicating that a characteristic time of control rod tip thermal diffusion will be specified
- DIAM** Di De : keyword followed by two real numbers  $0 < Di < De$  defining internal and external diameters of control rod tip (m). The characteristic time of thermal diffusion will be calculated assuming that control rod tip is made of steel.
- VALUE** tcond : keyword followed by a real  $> 0$  defining the characteristic time of thermal diffusion (s)
- COEFT** coeftip : keyword followed by a real  $0 \leq \text{coeftip} \leq 1$  defining the weighting factor between inlet and outlet core temperature to determine control rod tip average temperature :  
if  $\text{coeftip} = 0$ , control rod tip average temperature equals inlet core temperature  
if  $\text{coeftip} = 1$ , control rod tip average temperature equals outlet core temperature
- ROD** : keyword indicating that absorber rods characteristics will be given.
- LENGTH** lenabs : keyword followed by a real  $> 0$  defining the length of absorber rods (m)
- COEFT** coeftabs : keyword followed by a real  $0 \leq \text{coeftbar} \leq 1$  defining the weighting factor between inlet and outlet core temperature to determine absorber rod average temperature :  
if  $\text{coeftbar} = 0$ , absorber rod average temperature equals inlet core temperature  
if  $\text{coeftbar} = 1$ , absorber rod average temperature equals outlet core temperature
- COEFV** coefvcool : keyword followed by a real  $= 0$  defining the anti-reactivity coefficient resulting from coolant density variation (in \$)
- COEFT** coeftcool : keyword followed by a real  $0 \leq \text{coeftcool} \leq 1$  defining the weighting factor between inlet and outlet core temperature to determine coolant average temperature which is in contact with absorber rods :  
if  $\text{coeftcool} = 0$ , coolant average temperature equals inlet core temperature  
if  $\text{coeftcool} = 1$ , coolant average temperature equals outlet core temperature

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 112/851

<b>MECHA</b> meca1	: keyword indicating that the characteristics of absorber rods connected to the control rod drive mechanism mecha1 will be given. This keyword should be repeated as many times as there are control rod drive mechanisms involved in the control rod group insertion. It is followed by the list of absorber rods linked to the control rod drive mechanism.
<b>WORTH</b> worth1i	: keyword followed by a real > 0 defining the worth of the ith absorber rod (in pcm)
<b>WEIGHT</b> weight1i	: keyword followed by a real > 0 defining the weight of the ith absorber rod
<b>SCURVE</b>	: keyword indicating that absorber rod efficiency as a function of insertion depth in the core will be given. When the absorber rods are : fully inserted in the core, efficiency should be equal to 1 fully ejected from the core, efficiency should be equal to 0 For intermediate value of insertion depth, efficiency profile as function of insertion depth looks like a "S-shaped" curve. This curve can be defined by user either by using a polynomial function or a law.
<b>POLY</b>	: keyword indicating that the efficiency curve will be given as a polynomial function
<b>DEGREE</b> q	: degree of polynomial function
<b>COEF</b> c0...cq	: list of polynomial coefficients (from low order to high order terms)
<b>XMIN</b> insmin	: minimum value of control rod insertion depth (m) for which polynomial function should be used (to avoid side effects). If insertion depth is lower than this value, efficiency of absorber rods will be calculated using this minimum value.
<b>XMAX</b> insmax	: maximum value of control rod insertion depth (m) for which polynomial function should be used (to avoid side effects). If insertion depth is grater than this value, efficiency of absorber rods will be calculated using this maximum value.
<b>LAW</b> lawS	: keyword indicating that the efficiency curve will be given as a law. It should be followed by a law giving the evolution of efficiency as a function of insertion depth (m).
<b>SHADOW</b> vshadow	: keyword followed by a real $0 \leq vshadow \leq 1$ taking into account the absorber rods interaction : when at least two absorber rods are located nearby, they tend to shadow each other so that their total reactivity worth becomes less than the summation. The reactivity worth summation of absorber rods is then multiplied by vshadow coefficient to take into account such an effect
<b>INSERT</b> insini	: keyword followed by a real number defining the initial insertion depth of absorber rods in the core (m) for all mechanisms

### Example

```

MECA1 =   CONTROL      ROD      MECHA      CORE1
          LENGTH      3.
          TAU        DIAM      4.D-2       6.D-2 ;
MECA2 =   CONTROL      MECHA      CORE1
          ROD
          LENGTH      3.
SCP1 =    CONTROL      ROD      GROUP      CORE1
          TIP       LENGTH      3.
          TAU       VALUE      30.
          COEFT     1.

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 113/851

ROD	LENGTH	1.05	COEFT 0.2	
	COEFV	0.	COEFT 0.1	
	MECHA	MECA1	WORTH 500. WEIGHT 4	
			WORTH 750. WEIGHT 2	
	MECHA	MECA2	WORTH 500. WEIGHT 4	
			WORTH 750. WEIGHT 2	
SCURVE	POLY	DEGREE	5	
		COEF	8.1395D-3	
			1.9695D-1	
			6.9796D-1	
			3.4628D0	
			-5.1043D0	
			1.7322D0	
		XMIN	-0.05	
		XMAX	1.05	
SHADOW	1.			
INSERT	0.	;		
SCURVE =	LAW	'INSERT'	'WORTH'	
		-0.05	0.	
		0.2	0.1	
		0.5	0.5	
		0.8	0.9	
		1.05	1. ;	
SCP2 =	CONTROL	ROD	GROUP	CORE1
	TIP	LENGTH	3.	
		TAU	VALUE	30.
		COEFT	1.	
	ROD	LENGTH	1.05	COEFT 0.2
		COEFV	0.	COEFT 0.1
		MECHA	MECA1	WORTH 500. WEIGHT 4
				WORTH 750. WEIGHT 2
		MECHA	MECA2	WORTH 500. WEIGHT 4
				WORTH 750. WEIGHT 2
SCURVE	LAW	SCURVE	;	
SHADOW	0.9			
INSERT	0.	;		

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 114/851

33

## CONTROL ROD MECHA OPERATOR

The **CONTROL ROD MECHA** operator used in the data block creates a CONTROL ROD DRIVE MECHANISM type object.

### Associated Keywords

CORE, CONTROL ROD GROUP, GONEUT

### Syntax

elem =           **CONTROL**      **ROD**      **MECHA**      core1

$\begin{array}{l} \parallel \text{ LENGTH} \\ \parallel \text{ TAU} \\ \parallel \text{ or} \end{array}$	$\begin{array}{l} \text{Len1} \\ \text{DIAM} \\ \text{VALUE} \end{array}$	$\begin{array}{l} \text{Di1} \\ \text{tcond1} \end{array}$	$\begin{array}{l} \text{De1} \\ \quad \quad \quad \end{array}$
--	---	--	--

(...)

$\begin{array}{l} \parallel \text{ LENGTH} \\ \parallel \text{ TAU} \\ \parallel \text{ or} \end{array}$	$\begin{array}{l} \text{Len2} \\ \text{DIAM} \\ \text{VALUE} \end{array}$	$\begin{array}{l} \text{Di2} \\ \text{Tcond2} \end{array}$	$\begin{array}{l} \text{De2} \\ ; \end{array}$
--	---	--	--

**elem** : name of the control rod drive mechanism.  
**core1** : name of the core object for which the control rod drive mechanism will be taken into account.

This is followed by the list of geometrical properties of control rod drive mechanism elementary rods. The following keywords should then be repeated as many times as there are elementary rods in the control rod drive mechanism.

**LENGTH** len : keyword followed by a real  $> 0$  defining the length of elementary rod of control rod drive mechanism.  
**TAU** : keyword indicating that a characteristic time of elementary rod thermal diffusion will be specified.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 115/851

**DIAM Di De** : keyword followed by two real numbers  $0 < Di < De$  defining internal and external diameters of elementary rod. The characteristic time of thermal diffusion will be calculated assuming that elementary rod is made of steel.

**VALUE tcond** : keyword followed by a real  $> 0$  defining the characteristic time of thermal diffusion (s)

### Example

```

MECA1 =      CONTROL    ROD      MECHA      CORE1
              LENGTH     2.
              TAU        DIAM       4.D-2      6.D-2
              LENGTH     1.
              TAU        DIAM       2.D-2      4.D-2 ;

```

```

MECA2 =      CONTROL    ROD      MECHA      CORE1
              LENGTH     3.
              TAU        VALUE      30. ;

```

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 116/851</a>

34

## CONTROL-VALVE OPERATOR

The **CONTROL VALVE** operator used in the data block creates a CONTROL VALVE type object.

The CONTROL VALVE can be located either on a current vector mesh of an axial element, either between two elements. Junctions must be of type [AXIAL-VOLUME], [AXIAL-TEE].

The CONTROL VALVE operator only defines and locates the valve. To enable or disable the valve refer to the ENABLE and DISABLE directives.

### Associated Keywords

**ENABLE, DISABLE, VALUE FOR VALVE, WRITE FOR VALVE**

### Syntax

<b>elem =</b>	<b>CONTROL</b>	<b>VALVE</b>	<b>POINT</b>	<b>pipe1</b>	<b>pvect1</b>
	or	<b>JUNCTION</b>	<b>elem1</b>	<b>elem2</b>	
		<b>RO</b>	<b>roref</b>		
		<b>CV</b>	<b>law1</b>		
	or	<b>KM</b>	<b>law1</b>		
		<b>(TCVFUITE</b>	<b>tcvfuite )</b>		
		<b>(TCVENCER</b>	<b>tcvencr )</b>		
				;	

**elem** : name of the control valve (maximum 7 characters in case of junction location)

**POINT** : keyword indicating that the valve is located on a internal mesh of an axial element.  
**pipe1** : name of the pipe  
**pvect1** : name of the vector point where the CONTROL VALVE is located.

**JUNCTION** : keyword indicating that the CONTROL VALVE is located at a junction between a volume or a tee and an axial.

**elem1** : name of the volume or the tee  
**elem2** : name of the axial

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 117/851

<b>RO roref</b> <b>CV</b> <b>law1</b>  <b>or</b> <b>KM</b> <b>law1</b>  <b>TCVFUITE</b>  <b>TCVENCRR</b>	<p>: keyword followed by a real roref &gt; 0. roref is the reference fluid density for the valve specifications (kg/m<sup>3</sup>)  - If roref ≤ 500 kg/m<sup>3</sup>, the capacity is supposed to be defined in critical steam flow condition  - If roref &gt; 500 kg/m<sup>3</sup>, the capacity is supposed to be defined in sub-critical liquid flow condition</p> <p>: keyword indicating that the ‘PU’ ‘CV’ law (normalized valve capacity as a function of the position of the stem) is to be read. This is followed by :</p> <p>: ‘law’-type object defining the normalized law which gives the valve capacity as a function of the position of the stem. The position of the stem is in the [0,1] range.</p> <p>: keyword indicating for an application of type COMETE that the ‘PU’ ‘KM’ law (singular head loss of the valve as a function of the position of the stem) is to be read. This is followed by :</p> <p>: ‘law’-type object defining for an application of type COMETE, the law which gives singular head loss of the valve as a function of the position of the stem. The position of the stem is in the [1.D15,0] range.</p> <p>: OPTIONAL keyword followed by a real = 0 and = 1. tcvfuite is the normalised CV for maximum leakage according to CV<sub>max</sub>. Default value is 1.  <i>Remark</i> : Option not available for an application of type COMETE</p> <p>: OPTIONAL keyword followed by a real = 0 and = 1. tcvencr is the coefficient of proportionality of current CV for maximum fouling. Default value is 1.  <i>Remark</i> : Option not available for an application of type COMETE</p>
--	---

### Example

```

lvpi =      LAW        'PU'        'CV'
            0.          0.D0
            0.5         1.D+2
            1.          1.D+3      ;
vppi1 =    VECTOR     tuyvap1   42.9      ;
vpi1 =     CONTROL    VALVE    POINT      tuyvap1  pppi1
                    RO        ;           1.
                    CV        tuyvap2   ;
vpi2 =     CONTROL    VALVE    JUNCTION   cavite2  lvpi      ;
                    RO        tuyvap2   1.
                    CV        lvpi      ;
vpi3 =     CONTROL    VALVE    POINT      tuyvap1  pppi1
                    RO        1.
                    CV        lvpi      ;
                    TCVFUIITE  0.3D0    ;
rcp4 =     CONTROL    VALVE    JUNCTION   tee2     dechac2
                    RO        990.
                    CV        lvpi      ;
                    TCVENCRR  0.2D0    ;

```



lvkm =	LAW	'PU'	'KM'		
		0.	1.D15		
		0.05	1.D2		
		1.	0.5D0		
Vpil =	CONTROL	VALVE	POINT	tyvap1	pvpil
				RO	1.
				KM	lvkm

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 119/851

35

## CORE OPERATOR

The **CORE** operator creates a point kinetics model of the core region. The **CORE** operator is used in the *data block*. The core of a circuit is made up of several "regions". Each region may be modeled by AXIAL or THREED elements with fuel walls. The fuel walls are modeled by elementary fuels grouped together in fuel-structures. The **CORE** operator creates a core object, defining its characteristics.

In the present version, a NEWTON-RAPHSON method is used to solve point neutron kinetics equations.

- **NB1** : Only one CORE object can be defined per circuit. The **CORE** operator has to be used in conjunction with the **NEUTRO** option:

1. In the **FUEL**, or **FUEL3D** operator, which is used to define the neutron characteristics of each fuel wall in each of the fuel-structures of the core elements.
2. In the **FUELCHAR** operator, which is used to define the neutron characteristics of the fuel-structures of the core elements.

The **CORE** operator has to be used **after** the walls (**FUEL**, **FUELPLAQ** operator) and fuel characteristics (**FUELCHAR** operator) have been defined and integrated (**INTEGRATE** directive) into the elements making up the core.

It must be used also after the definition of a **BYPASS** axial sub-type element.

- **NB2** : The CORE object can be used for three types of applications:

1. a standard Pressurized Water Reactor **PWR**,
2. a gas cooled reactor (High Temperature Reactor **HTR**, or gas fast reactor),
3. a liquid-metal-cooled Fast Neutron Reactor **FNR**,

For **FNR** applications, **LAWMODER**, **MODERAT**, **DOPPLER** and **BORON OPTIONAL** keywords are not available.

For **HTR** applications (**HTR** keyword in **CORE**), only the **FUELPLAQ** operator is available (**HTR** keyword in **FUELPLAQ** operator).

- **NB3** : The CORE object has to be added in the list of the circuit element (see **CIRCUIT** operator) to be taken into account.

### Associated Keywords

SCRAM, GONEUT, STOPNEUT, FUEL, FUEL3D, FUELCHAR, XNEULIST, XNEULISX, ROROD, VALUE FOR CORE

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>

### Syntax

core1 =      **CORE**      (**HTR**      or      **FNR**)

**PO**      po

**(KEFF**      ko )

**CORENAME** elem1      elem2      ....      elemn)

**USER**

or

<b>BETA</b>	beta			
<b>BETADN</b>	beta1	(beta2	...	betan)
<b>DNDECAY</b>	decro1	(decro2	...	decrone)
<b>RESENER</b>	ej1	(ej2	...	ejnj)
<b>RESDECAY</b>	zj1	(zj2	...	zjnjj)
or	lawresid	<b>(RELTIME)</b>		
<b>LAWRESID</b>				
<b>LIFETIME</b>		lifetime		

(IF **PWR** :)

    (**MODERAT**      xrmmod1      xrmmod2      xrmmod3      xrmmod4 )

    or

    (**MODERAT**      **LINEARIZ**      xrmmod1      xrmmod2      xrmmod3 )

    or

    (**LAWMODER**      lawmoder)

(IF **PWR** :)

    (**DOPPLER**      xrdop1      xrdop2      xrdop3      xrdop4 )

    or

    xrdop )

(IF **PWR** :)

    (**BORON**      (**DENSITY**)      xrbor1      xrbor2 )

    or

    (**BORON**      (**LINEARIZ**)      xrbor1      xrbor2      xrbor3 )

(IF **HTR** :)

    (**CSPLATE**      **TAU**      **VALUE**      tau )

        (**COEFV**      or**DIAM**      Dint      Dext)

        coefv)

IF **FNR** :

**CSPLATE**      **TAU**      **VALUE**      tau

**COEFV**      or**DIAM**      Dint      Dext

        coefv)

(IF **FNR** :)

    (**CONTPAD**      **DTPAD**      dtemp) ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 121/851

<b>HTR</b> <b>FNR</b>  <b>PO</b>  <b>KEFF</b>  <b>CORENAME</b> <b>elem1</b> <b>... elemn</b>  <b>USER</b>	: OPTIONAL keyword which indicate that a gas cooled reactor type will be computed. : OPTIONAL keyword which indicate that a liquid-metal-cooled Fast Neutron Reactor type will be computed. : keyword to indicate that the initial effective power of the core for all the fuel rods of all the core hydraulic elements is going to be entered. This value is followed by a real number $\geq 0$ . : OPTIONAL keyword to indicate that the initial effective multiplication factor of the core is going to be entered. This value is followed by a real number $\geq 0$ . If the multiplicative factor is different from unity, a neutronic source term is automatically added to ensure core equilibrium. : keyword followed by one or several names of axial elements. This information is not used by the code but mandatory for compatibility with old input decks  : OPTIONAL keyword to indicate that the user is going to enter the values for NDNGROUP, BETA, BETADN, DNDECAY, NRSGROUP, RESENER, RESDECAY, LIFETIME with a personal library (LIBNEU program).
--	--

If the keyword USER is not used, the following data should be entered:

<b>BETA</b> <b>BETADN</b>  <b>DNDECAY</b> <b>RESENER</b> <b>RESDECAY</b> <b>LAWRESID</b>  <b>LIFETIME</b>	: keyword to enter the value of the total effective delayed-neutron fraction. This is followed by a real number $> 0$ (non dimensional). : keyword to enter the values corresponding to the effective delayed-neutron fraction of the delayed-neutron groups. This is followed by real numbers $\geq 0$ (non dimensional). The sum of the effective delayed-neutron fraction of the delayed-neutron groups should be equal to the total effective delayed-neutron fraction (keyword <b>BETA</b> ). : keyword to enter the decay constants for the delayed-neutron precursors of the delayed-neutron groups ( $\text{second}^{-1}$ ). This is followed by real numbers $\geq 0$ . : keyword to enter the effective energy fraction of residual energy for the decay-heat groups. This is followed by real numbers $\geq 0$ . : keyword to enter the decay constants for the actinides and fission products of the decay-heat groups ( $\text{second}^{-1}$ ). This is followed by real numbers $\geq 0$ . : keyword to enter the law of actinides and fission products decay power (residual power) as a function either of absolute time or relative time (with respect to the time when GONEUT directive is activated for the first time) if <b>RELTIME</b> keyword is used . This is followed by a LAW giving the value of residual power divided by initial effective power of the core (keyword <b>PO</b> ) as a function of time. In such a case, the keyword DOPPLER (available for <b>PWR</b> application only) is expected with only one coefficient. : keyword to enter the prompt-neutron generation time (second). This is followed by a real number $\geq 0$ .
---	---

Three other coefficients can be entered to deal with the anti-reactivity calculations in case of **PWR** applications (in case of **HTR** and **FNR** applications, the coefficients are entered for each FUELPLAQ, see FUELPLAQ operator; in case of an application with a BYPASS sub-type, the coefficients are entered for each BYPASS, see **BYPASS** directive ) :

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 122/851

## MODERAT

: OPTIONAL keyword to be used only for a **PWR** application. It describes the anti-reactivity coefficient (R in \$) as a function of the moderator density ( $\rho$  in kg/m<sup>3</sup>) by its differential efficiency. The (default) standard formulation is :

$$\frac{dR}{d\rho} = -\left(\frac{xmod1}{\rho} + xmod2 + xmod3 \cdot \rho + xmod4 \cdot \rho^2\right)$$

LINEARIZ optional keyword triggers the following linear formulation :

$$\frac{dR}{d\rho} = xmod1 + xmod2 \cdot \rho + xmod3 \cdot Cb$$

with Cb the soluble mass concentration of boron in liquid water

This anti-reactivity effect is calculated at each point of the axial element and will be taken in place of the anti-reactivity coefficient calculated with the COEFM moderator density entered in each FUELCHAR object defined on the element.

### Warning :

When using this function method, the profile defined in the FUEL (or FUEL3D, FUELPLAQ) operator for this coefficient will not be taken into account.

: OPTIONAL keyword to be used only for a **PWR** application. Enables the user to enter the law of moderator reactivity (pcm) as a function of core density (kg.m<sup>-3</sup>).

It is followed by a LAW giving the moderator reactivity as a function of core density.

Available only if keyword **LAWRESID** is used.

: OPTIONAL keyword to be used only for a **PWR** application. It describes the anti-reactivity coefficient (R in \$) as a function of the mean temperature of the **UO<sub>2</sub>**(T in K) by its differential efficiency :

If keyword **LAWRESID** is not used

$$\frac{dR}{dT} = \frac{xrdop1}{T} + xrdop2 + xrdop3 \cdot T + xrdop4 \cdot T^2$$

*The keyword is followed by the 4 real positive numbers xrdop1, xrdop2, xrdop3, xrdop4 (R is an increasing function of T). The default value of these coefficients is 0.*

The coefficient is calculated at each of the axial element points and will be taken in place of the anti-reactivity coefficient calculated with the DOPPLER effect COEFD entered in each FUELCHAR object defined on the element. Besides, the profile defined in the FUEL (FUEL3D, FUELPLAQ) operator for this coefficient will not be taken into account.

### Case of use of keyword **LAWRESID**

COMPULSORY keyword describing the anti-reactivity coefficient (R in \$) as a function of the mean Rowlands temperature of the **UO<sub>2</sub>**(in K) by its differential efficiency :

$$\frac{dR}{dT} = B$$

This keyword is followed by one real number : B.

## BORON

: OPTIONAL keyword to be used if neutron calculation is made with BORON.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 123/851

**DENSITY**  
 xrbor1 xrbor2 :OPTIONAL keyword which describes, when it is used, the antireactivity (R in \$) as a function of  $\rho_L$  the liquid density and of (Cb) the soluble mass concentration of boron in liquid water by its differential efficiency :

$$\frac{dR}{dCb} = xrbor1 \cdot \rho_L + xrbor2 \cdot \rho_L^2 \cdot Cb$$

By default, (without DENSITY keyword), the antireactivity (R in \$) is computed as a function of (Cb) the soluble mass concentration of boron in liquid water by its differential efficiency :

$$\frac{dR}{dCb} = xrbor1 + xrbor2 \cdot Cb$$

It is followed by the two real positive numbers xrbor1, xrbor2 (R is an increasing function of Cb).

**LINEARIZ**  
 xrbor1 xrbor2 xbor3 :OPTIONAL keyword which describes, when it is used, the antireactivity (R in \$) as a linear function of  $\rho_L$  the liquid density and of (Cb) the soluble mass concentration of boron in liquid water by its

$$\frac{dR}{dCb} = xrbor1 + xrbor2 \cdot Cb + xrbor3 \cdot \rho_L$$

Other coefficients can be entered to deal with the anti-reactivity calculations in case of **FNR** applications :

**CSPLATE** : COMPULSORY keyword to be used only for a **FNR** application.  
 : OPTIONAL keyword used for a HTR application.

It is followed by two keywords :

**TAU** is used to describe the core support plate conductive time constant, either by specifying a value (in s, using keyword **VALUE**) or by giving its internal and external diameters (in m, using keyword **DIAM**). This time constant is used to calculate the evolution of average core support plate temperature by solving a simplified wall conduction equation.

**COEFV** is used to describes the anti-reactivity (R in \$) of core support plate as a function of its average temperature by its differential efficiency. It is followed by coefficient A, such as :

$$\frac{dR}{dT} = A$$

**CONTPAD** : OPTIONAL keyword to be used only for a **FNR** application. COMPULSORY keyword if any contact pad is defined in the **FUELPLAQ** definition (see **FUELPLAQ** operator).

**DTPAD** : keyword is followed by a positive value, which is the limit average temperature difference between contact pads and the diagrid. Above this value the core is no longer compact.

**NB** : \$ is pcm/BETA(in pcm)

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 124/851

**Example**

Standard PWR application

```

core1 =      CORE
             PO      68290.d0
             KEFF    0.98
             CORENAME corecho
             USER
             MODERAT 0.1      0.3      0.88      0.99
             BORON   1.0      0.5

core2 =      CORE
             PO      2.8305d9
             CORENAME meancore
             BETA   0.0076d0
             BETADN 2.4d-4   1.5d-3   1.5d-3
                     3.1d-3   1.1d-3   1.6d-4
             DNDECAY 0.0286d0 0.0327d0 0.1129d0
                     0.2667d0 1.4055d0 2.9004d0
             RESENER  0.00378d0 0.00678d0 0.02678d0
                     0.02888d0 0.02578d0 0.00123d0
                     0.00078d0 0.00067d0 0.00042d0
                     0.00023d0 0.00011d0
             RESDECAY 1.565d0   5.566d-1  4.997d-2
                     9.896d-3  6.786d-4  7.785d-5
                     2.896d-6  1.366d-7  4.994d-7
                     3.226d-8  9.562d-10
             LIFETIME 35.0d-6   ;

```

Examples using the LAWRESID keyword (PWR application)

```

LPRES =      LAW          'TIME'      'POWER'
             0.00        0.04529
             0.1         0.04504
             0.5         0.04409
             1           0.04300
             4           0.03829
             10          0.03377
             40          0.02696
             100         0.02357

```

```

Core3 =      CORE
             PO      2.8305d9
             CORENAME meancore
             BETA   0.0076d0
             BETADN 2.4d-4   1.5d-3   1.5d-3
                     3.1d-3   1.1d-3   1.6d-4
             DNDECAY 0.0286d0 0.0327d0 0.1129d0
                                         0.2667d0

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 125/851

LAWRESID	1.4055d0	2.9004d0		
LIFETIME	LPRES			
MODERAT	35.0d-6			
DOPPLER	0.1	0.3	0.88	0.99
	0.007521d0 ;			

#### Standard Navy power Plant application

Core4 =	CORE			
	PO	68290.d0		
	KEFF	0.98		
	CORENAME	corecho		
	USER			
	MODERAT	0.1	0.3	0.88
	BORON	DENSITY	1.0	0.5 ;

#### HTR application

Core5 =	CORE	<b>HTR</b>		
	PO	2.8305d9		
	CORENAME	meancore		
	BETA	0.0076d0		
	BETADN	2.4d-4	1.5d-3	1.5d-3
		3.1d-3	1.1d-3	1.6d-4
	DNDECAY	0.0286d0	0.0327d0	0.1129d0
		0.2667d0	1.4055d0	2.9004d0
	RESENER	0.00378d0	0.00678d0	0.02678d0
		0.02888d0	0.02578d0	0.00123d0
		0.00078d0	0.00067d0	0.00042d0
		0.00023d0	0.00011d0	
	RESDECAY	1.565d0	5.566d-1	4.997d-2
		9.896d-3	6.786d-4	7.785d-5
		2.896d-6	1.366d-7	4.994d-7
		3.226d-8	9.562d-10	
	LIFETIME	35.0d-6 ;		
	CSPLATE	TAU	DIAM	0.175
		COEFV	8.679D-6	;

#### FNR application

Core6 =	CORE	<b>FNR</b>		
	PO	125.d6		
	CORENAME	ASS1	ASS2	ASS3
		ASS5	ASS6	BYPASS
	BETA	3.5095d-3		
	BETADN	6.01D-5	6.698D-4	3.723D-4

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 126/851

DNDECAY	1.2923D-3 1.25D-2 2.68D-1	8.228D-4 2.94D-2 6.7D-1	2.922D-4 9.21D-2 2.8D0
RESENER	5.066D-2 8.346D-3	1.014D-2	5.856D-3
RESDECAY	3.189D-3 2.071D-6	2.827D-4	3.496D-5
LIFETIME	2.4615D-7		
CSPLATE	TAU		
DIAM	0.175	0.19	
COEFV	8.679D-6		
CONTPAD	DTPAD	100.D0 ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 127/851

36

## DEGRE OPERATOR

The DEGRE operator is used to convert the measure of an angle from radian to degree. The result is a real number (DOUBLE)

### Associated Keywords

MATHEMATIC, TRIGONOMETRIC, ABSOLUTE, EXP, NEQ, AND, MAX, MIN, OR, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF

### Syntax

`z = DEGRE (x) ;`

### Example

`180 = DEGRE ( $\pi$ ) ;`

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 128/851

37

## DISABLE DIRECTIVE

The **DISABLE** directive, in the *command block*, disables a CCFL object or deactivates the JETPUMP option of the TEE. It also allows to disable gadgets like BREAK, SINK, SOURCE, CANDLE, CHECKVALVE, CONTROLVALVE, FLOWLIMITER, ECVALVE, ECHECK, PIQARE, PIQVANNE, PIQREV, PIQSEB, PIQSOUP and SINKRRI. Like the CCFL object, gadgets used in the DISABLE directive must have been previously enabled by the ENABLE directive.

The CCFL object used in the **DISABLE** directive must have been previously enabled by the **ENABLE** directive.

To activate the JETPUMP option, use ENABLE directive.

WARNING : in case of non independent valve, the CLOSE directive must only be applied to the group

### Associated Keywords

ENABLE, CCFL, TEE, BREAK, SINK, SOURCE, CANDLE, CHECK VALVE, CONTROL VALVE, FLOW LIMITER, ECVALVE, ECHECK, PIQARE, PIQVANNE, PIQREV, PIQSEB, PIQSOUP, PIQBREK, SGTR, SINKRRI

### Syntax

```
DISABLE ccfl;
or
JETPUMP pipe tee1 ... teen ;
or
GADGET
```

<b>ccfl</b>	: 'ccfl' type object
or	
<b>JETPUMP</b>	: keyword to deactivate the JETPUMP option of the tee(s)
pipe	: name of the AXIAL carrying the tee(s)
tee1 or	
<b>GADGET</b>	: name of the gadget
	: a tee name or a list of tee names belonging to the same pipe
...	
teen	

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 129/851</a>

38

## DOUBLE DIRECTIVE

This directive of the *command block* allows the declaration of the **DOUBLE PRECISION** -type variable that will be used in the command block.

It must be used at the top of the *command block*, BEFORE ANY executable statement such as RESTORE, OPTION, TABLE...

It may be used one or several times, anywhere among other declarations made by INTEGER and CHAR8.

All DOUBLE PRECISION variables of the *command block* will be SAVED in V25\_3.RESTART file.

These variables are automatically restored when using RESTORE directive in a restart calculation.

### Associated Keywords

**CHAR8, INTEGER, TABLE**

### Syntax

**DOUBLE**      **TIME**      **DT**      **XVAL**      ...      ;

**TIME**      : list of the DOUBLE PRECISION variables to be declared  
**DT**  
**XVAL**

**Warning :** Contrary to the older CATHARE2 version (before the V2.5 series) local variables are automatically restored in restart calculations. The use of TABLE directive is then obsolescent and should be suppressed.

### Example

```
END      DATA      ;  

DOUBLE    TIME      DT      XVAL;  

...  

RESTORE   ;
```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 130/851</a>

39

## DTMASS3D DIRECTIVE

The **DTMASS3D** directive is used in *the command block* to maintain at least the new step time at its preceding value when the relative global mass error in a 3D element is over the user's value specified in the directive.

### Associated Keywords

THREED

### Syntax

**DTMASS3D**    element                mass\_error            ;

<b>element</b> <b>mass_error</b>	: Name of the threed-type object; : Real value (%) defining the global mass error admitted in the 3D element. When the calculated mass error is over this value, the time step increasing is stopped and it is maintained at least to its preceding value.
-------------------------------------	---

**N.B** : the FORTRAN subroutine called in PILOT is MOPTIOP.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 131/851

40

## ECHECK OPERATOR

The **ECHECK** operator is used in the *data block* to create an ECHECK type object, representing a group of VEC (a CHECK VALVE and a CONTROL VALVE).

**Warning :** All the VEC that belong to an **ECHECK** operator must be defined on the same point and have the same reference fluid density RO.

Use ENABLE / DISABLE directives in the command block to connect/ disconnect the group of valves.

### Associated Keywords

ENABLE, DISABLE, VALUE FOR VALVE, WRITE FOR VALVE

### Syntax

```
elem =      ECHECK      clap1      van1      ;
```

<b>elem</b>	: name of the ECHECK group (maximum 7 characters in case of junction location)
<b>clap1</b>	: name of the check valve that belongs to the group
<b>van1</b>	: name of the control valve that belongs to the group

### Examples

Definition of the CP321VP check valve located on the junction with COLD3

```
RCP321VP=  = CHECK      VALVE      JUNCTION      TEJ18      REFBF3
          RO         999.2
          CV         4472.D0
          DP        -0.001D5      ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 132/851

Definition of the RRA015VP control valve located on the junction with COLD3

```
LCL4V      = LAW          'PU'        'CV'
            0.00          1.D-5
            1.00          4315.D0    ;
RRA015VP=  CONTROL       VALVE      JUNCTION   TEJ18      REFBF3
           RO           999.2
           CV           LCL4V     ;
```

Definition of the equivalent valve CRRABF3 (RRA015VP & RCP321VP)

```
CRRABF3    = ECHECK      RCP321VP    RRA015VP    ;
```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 133/851</a>

41

## ECHPOWER DIRECTIVE

The **ECHPOWER** directive, compulsory if there are exchangers, is used after the **PERMINIT** directive and before the **GOPERM** directive, in the *command block*, to impose the power to be exchanged through the exchangers during the steady state.

### Associated Keywords

**ECHPOWER, PERMINIT, GOPERM**

### Syntax

**ECHPOWER** exchi                pwi;

<b>exchi</b>	: exchanger_name.
<b>pwi</b>	: power (W)

### Example

ECHPOWER ECHI 927.D6 ;  
 ECHPOWER ECHR 927.D6 ;

**NB :** The corresponding FORTRAN subroutine called in PILOT is STDPOW. The arguments are the following ones :  
 CALL STDPOW ( OBJNAM, RVAL, \*9999)

<b>OBJNAM</b>	CHARACTER*8 name of the exchanger element
<b>RVAL</b>	DOUBLE PRECISION value of the power to be assigned to the exchanger

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 134/851

42

## ECVALVE OPERATOR

The **ECVALVE** operator is used in the *data block* to create an ECVALVE type object, representing a group of VEC (a combination of FLOW LIMITER and CONTROL VALVE in the limit of two VEC on the main line and two VEC on the bypass line).

**Warning :** All the VEC that belong to an **ECVALVE** operator must be defined on the same point and have the same reference fluid density RO.

Use ENABLE / DISABLE directives in the command block to connect/ disconnect the group of valves.

### Associated Keywords

ENABLE, DISABLE, VALUE FOR VALVE, WRITE FOR VALVE

### Syntax

```
elem =      ECVALVE    PRINC      n1          VEC_i
            (BYPASS)   n2          VEC_j       ;
```

<b>elem</b>	: Name of the ECVALVE group (maximum 7 characters in case of junction location)
<b>PRINC</b>	: Keyword indicating that the following VEC (FLOW LIMITER or CONTROL VALVE) will be placed on the main line.
<b>n1</b>	: Integer (= 2) defining the number of VEC on the main line.
<b>VEC_i</b>	: Name of the VEC (FLOW LIMITER or CONTROL VALVE) placed on the main line.
<b>BYPASS</b>	: OPTIONAL keyword indicating that the following VEC (FLOW LIMITER or CONTROL VALVE) will be placed on the bypass line.
<b>n2</b>	: Integer (= 2) defining the number of VEC on the bypass line.
<b>VEC_j</b>	: Name of the VEC (FLOW LIMITER or CONTROL VALVE) placed on the bypass line.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 135/851

<b>Example</b>
----------------

Definition of the equivalent valve RRAREGQ (RRA012VP + RRA026VP + RRA01DI)

```

RRA012VP= CONTROL VALVE POINT SORECH1 POSV10
          RO      999.2
          CV      LV12   ;
RRA026VP= CONTROL VALVE POINT SORECH1 POSV10
          RO      999.2
          CV      LV26   ;
RRA01DI = FLOW    LIMITER POINT SORECH1 POSV10
          SR      2.36D-3 ; 
RRAREGQ= ECVALVE PRINC   1     RRA012VP
          BYPASS   2     RRA026VP   RRA01DI ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 136/851

43

## ELSE DIRECTIVE

Statements can be conditionally executed using the **ELSE** directive. It is used after a **IF** directive in the *command block* only.

### Associated Keywords

REPEAT, END, IF, ENDIF, QUIT, AND, OR

### Syntax

```

IF      ...      ;
...
ELSE    ;
IF      ...      ;
...
ELSE    ;
...
ENDIF   ;
ENDIF   ;
;
```

### Example

```

IF      ( xpres      <      117.5d5      AND
          iis        EQ      0 )      ;
          iis =      1      ;
          tisp30 =   time     +
                      30.      ;
ELSE    ;
          IF      ( time      >      tisp30      AND
              iis        EQ      1 )      ;
              iis =      2      ;
              open       ss1      ;
          ENDIF   ;
ENDIF   ;
;
```

44

# ENABLE DIRECTIVE

The **ENABLE** directive, in the *command block*, enables a CCFL object or activates the JETPUMP option of the TEE. It also allows to enable gadgets like BREAK, SINK, SOURCE, CANDLE, CHECKVALVE, CONTROLVALVE, FLOWLIMITER, ECVALVE, ECHECK, PIQARE, PIQVANNE, PIQREV, PIQSEB, PIQSOUP and SINKRRI.

To disable CCFL calculation, use **DISABLE** directive. To deactivate the JETPUMP option, use **DISABLE** directive.

### **Associated Keywords**

**DISABLE, CCFL, TEE, BREAK, SINK, SOURCE, CANDLE, CHECK VALVE, CONTROL VALVE, FLOW LIMITER, ECVALVE, ECHECK, PIQARE, PIQVANNE, PIQREV, PIQSEB, PIQSOUPI, SINKRRI, SGTR**

**NB :**

1. For an **external SOURCE**, the ENABLE directive checks the consistency of the imposed **CATHARE Computational Variables (CCV)**. If the liquid (and/or gas) flowrate is  $\neq 0$ , the liquid (and/or gas) temperature (or equivalent variable) must be defined by means of WRITE directive. Moreover the WRITE directive should be used before the DISABLE directive is used.
  2. For **PIQSEB**, **PIQVANNE** or **PIQSOUP**, the external pressure should have been defined through CCV before connecting the gadget.
  3. For **PIQREV** gadget, beware that the external conditions have to be defined in case of entering flow rate from the outside.

**Warning :** in case of non independent valve (control valve or check valve belonging to a group ECHECK or ECVALVE), the ENABLE directive must only be applied to the group.

**NB:** Using **ENABLE** directive to activate the SGTR is possible only if UNIQ keyword was used in SGTR definition. In that case there is no delay in the opening and the break is fully open.

## Syntax

**ENABLE**    ccfl  
              or  
              **JETPUMP**    pipe              tee1              ...              teen              ;  
              or **gadget**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 138/851

**ccfl** : ccfl-type object

or

**JETPUMP** : keyword to activate the JETPUMP option of the tee(s)

**pipe** : name of the AXIAL carrying the tee(s)

**tee1 ... teen** : a tee name or a list of tee names belonging to the same pipe

or

**gadget** : name of a gadget in the list define above.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 139/851

45

## END DIRECTIVE

### Associated Keywords

REPEAT, ELSE, IF, ENDIF, QUIT, AND, OR

### Syntax

The END directive is used :

1. **To terminate a block started with REPEAT (command block)**

```
REPEAT      BLOCKn      nn ;
...
;
END        BLOCKn      ;
```

2. **To terminate the data part of the input deck (data block)**

**END DATA ;**

After this directive, begins the command block of the input deck .

3. **To terminate the command block of the input deck (command block)**

**END EXEC ;**

This directive is the last of the input deck .

 <p>DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b>  SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/  RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 140/851

# 46

## ENDIF DIRECTIVE

The **ENDIF** directive, which can be used in *command block* only, terminates blocks beginning with IF or ELSE.

### Associated Keywords

REPEAT, END, IF, ELSE, QUIT, AND, OR

### Syntax

```

IF ; ...
; ;
ENDIF ;
IF ... ;
; ...
ELSE ;
; ...
ENDIF ;
;
```

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 141/851

47

## EQ OPERATOR

The **EQ** operator compares two operands (real numbers or integers). The **EQ** operator has to be used within a test in command block only. The commands following the comparison up to the corresponding ENDIF or ELSE directive will be executed if the comparison is **TRUE**. The **EQ** directive is used in the command block.

### Associated Keywords

MATHEMATIC, TRIGONOMETRIC, ABSOLUTE, EXP, NEQ, AND, MAX, MIN, OR, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF

### Example

```
IF          ( A           EQ           B )           ;  
          ...;  
ENDIF       ;
```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 142/851

48

## EXCHANGER OPERATOR

The **EXCHANGER** operator, used in *data block*, creates a heat exchanger between two parts of hydraulic components by defining its characteristics. Two types of heat exchangers are available depending on the time marching numerical scheme adopted:

The first type is based on an explicit scheme and couples two separate circuits. The second type is based on a quasi-implicit scheme and allows coupling separate circuits but also coupling elements of a single circuit.

For the walls of exchangers, internal heat power generation may be defined by the user through the directive EXCPOWER (command block).

**N.B.:**

- An exchanger must be defined before the circuit is created.
- An exchanger cannot be defined between an axial and a threed element.
- An exchanger cannot be defined with **BCONDIT**, **VOLUME** or **TEE**.

**Warning:** If the exchanger is defined between two different elements (axial), it is mandatory to create and define first the axial element modeling primary side and then the one modeling secondary side.

WRONG	RIGHT
Pipe2 = AXIAL ...; Pipe1 = AXIAL .... ; ... ECH1 = EXCHANGER Pipe2 Pipe1 ...;	<b>Pipe1</b> = AXIAL ...; <b>Pipe2</b> = AXIAL .... ; ... ECH1 = EXCHANGER Pipe2 Pipe1 ...;

**Associated Keywords**

COMPONENT, ECHPOWER, EXCPOWER, VALUE FOR EXCHANGER, WRITE FOR EXCHANGER

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 143/851

## 48.1 Explicit exchanger between two circuits

The exchanger is defined on pairs of segments, with one segment belonging to a secondary AXIAL element and the other to a primary AXIAL element.

Each segment is defined by two vector points which **must belong** to the element. The total lengths of these two segments must be equal, except if they are non-parallel. In this case, different lengths are allowed, but only for those cells which are non parallel. If one of the hydraulic segments has only one cell, the wall meshing is being built by fitting on the other hydraulic meshing which has more than one cell.

If different explicit exchangers are defined, they must be defined between the first circuit related to the first explicit exchanger and another circuit. For example, an input deck contains three circuits:

1. if the first explicit exchanger is defined between the first and the third circuit, all the others explicit exchangers should be defined between the first and the second or the third circuit.
2. if the first explicit exchanger is defined between the second and the third circuit, all the others explicit exchangers should be defined between the second and the third circuit.

### Syntax

<b>p1 = EXCHANGER</b> elemesec      elempri <b>PRIMARY</b> (or <b>SECONDARY</b> ) <b>(PRIAXIS</b> or <b>SECAXIS</b> ) <b>(MERGE)</b> <b>CYLINDER</b> (or <b>PLANE</b> )	<b>SEGMENT</b> ISk      ISn <b>DIRECT</b> (or <b>REVERSE</b> ) material1      IPi      IPj <b>DATA nm1</b> <b>DIAM</b> (or <b>THICK</b> )      d1 d2 ...      dnm1+1	<b>DATA nm1</b> <b>DINI</b> (or <b>THINI</b> )      dl1 d21 ...      dnm11+1 <b>DEND</b> (or <b>THEND</b> ) d12 d22      dnm12+1 ...	<b>ISO</b> nm1 <b>DIAM</b> (or <b>THICK</b> )	
				<b>To</b> <b>be</b> <b>re-</b> <b>peated</b> <b>as</b> <b>many</b> <b>times</b> <b>as</b> <b>needed</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 144/851

```

di dext
or
ISO nm1      DINI          di1 dext1
(or)           THINI        di1 dext1
DEND          THEND)       di2 dext2
(or
(but)
di2 dext2

(material2      ...)

HPERIM
POINT          IP1            peri1
IP2            peri2
(IP3 and IPj)  peri3
...
or
CONST          peri
;
;
```

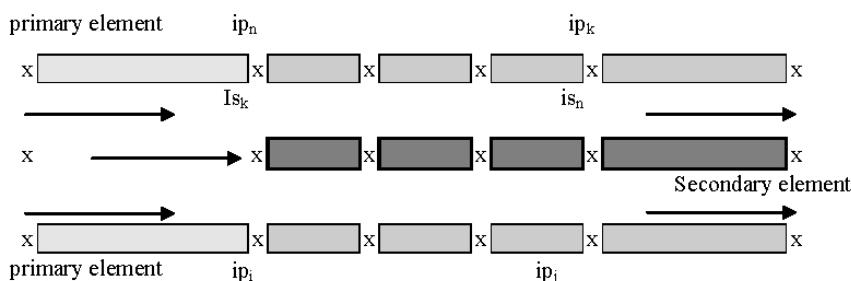


Figure 48.1.1: EXCHANGER : Explicit exchanger between two circuits

<b>elemsec</b>	: axial element belonging to the secondary circuit.
<b>elempri</b>	: axial element belonging to the primary circuit.
<b>CYLINDER</b> <b>(or PLANE)</b>	: keyword indicating that the conduction calculation is to be done in cylindrical geometry. CYLINDER will be replaced by the keyword PLANE if the calculation is to be done in plane geometry. <b>If PLANE is used, dimension data is given through THICK, THINI and THEND keywords and represents dimension in the direction perpendicular to the plane.</b>

The two following keywords aimed at defining the wall exchanger meshing :

<b>PRIMARY</b> <b>(or</b> <b>SECONDARY)</b>	: keyword indicating the radial orientation of the exchanger meshing . For a cylinder exchanger, PRIMARY means that the diameters of the wall are increasing from the primary towards the secondary circuit (the element of the primary circuit will be considered as the primary (or internal) side of the exchanger) . PRIMARY will be replaced by the keyword SECONDARY if these diameters increase from the secondary towards the primary.
---	--

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
<b>PRIAXIS (or SECAXIS)</b>	<p>: OPTIONAL keyword defining the axial hydraulic meshing reference for the exchanger meshing. By default (if no keyword is given), the axial reference is the same as the radial one.</p> <p>Most of the time the default value is the easiest, but :</p> <p>It has to be changed when the axial hydraulic meshing reference has only one cell facing the exchanger wall. (PRIAXIS (or SECAXIS) is not allowed when the primary (or the secondary) side has only one cell.)</p> <p>It may be changed when the two hydraulic components are non parallel : the wall meshing will be fitted on the reference hydraulic meshing and then the length of non parallel cells of the exchanger will be different depending on this choice. Nevertheless, in this case, the default option is recommended (no keyword is given, so that the wall meshing will be fitted on the “internal” side hydraulic meshing).</p>	<b>Document technique DEN</b>

<b>MERGE</b>	<p>: mandatory keyword when primary and secondary side are along the same axis and that their hydraulic meshing do not correspond mesh by mesh. The exchanger will be defined with respect to the PRIAXIS or SECAXIS choice.</p>	<b>To be re- peated as many times as num- ber of seg- ments</b>
<b>SEGMENT</b>	<p>: keyword indicating that two pairs of points are to be read, one belonging to the “elemsec” element, the other to the “elempri” element, and between which an exchanger is to be defined. It is followed by :</p>	
<b>ISs ISw</b>	<p>: vector points which must belong to the axial meshing of the secondary element and which define the start and end of the secondary exchange zone.</p> <p>These two points must be given in the order in which the secondary hydraulic meshing has been described.</p>	
<b>DIRECT (or REVERSE)</b>	<p>: keyword preceding the pair of primary points when primary and secondary meshings are described in the same direction.</p> <p>DIRECT is replaced by REVERSE when primary and secondary meshings are described in the opposite direction.</p>	
<b>IPk IPn</b>	<p>: Vector points which <b>must</b> belong to the axial meshing of the primary element and which define the start and end of the primary exchange zone.</p> <p>These two points must be given in the order in which the primary hydraulic meshing has been described.</p>	

<b>material1</b>	<p>: imposed keyword defining the nature of the material used, to select from the following list :</p>	<b>MgO TOPHET<sup>1</sup> NITRBORE ACIER533 ACIER508 INOXVES<sup>2</sup> INOX304 INOX316 INOX347 INCON600 INCON690 INCON718</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 146/851</a>

INCON800 INCON625 LOB14948 CERAMIC NI201 LOB14571 GAP ZIRCALOY AL2O3 XXXXXXi	Inconel 800 Inconel 625 1.4948 (Lobi Loop) Ceramic (Al <sub>2</sub> O <sub>3</sub> ) Ni 201 1.4571 (Lobi Loop) 100% Helium zircaloy Al <sub>2</sub> O <sub>3</sub> (Alumin for REBEKA) (i=1,6) user defined material name (FWMAXX subroutine to be defined in the range 28 to 33 ) Name given to a material defined with the MATERIAL operator	<b>To be repeated as many times as number of materials</b>	<b>To be repeated as many times as number of segments</b>
<b>NB:</b> Materials will be given in increasing order of diameters (from the primary to the secondary if the keyword given previously was PRIMARY, or from the secondary to the primary if the keyword was SECONDARY).			

<b>*Radial mesh</b>  <b>1) DATA nm1</b>  <b>DIAM d1 d2</b> ... <b>dnm1+ 1</b>  or <b>THICK d1 d2</b> ... <b>dnm1+ 1 (case of a PLANE exchanger)</b>	The radial mesh data (m) will be given in increasing order.  ⇒ Two possibilities to enter the radial mesh of the wall  : keyword indicating that the radial mesh will be defined mesh by mesh by the user. This is followed by an integer > 0 defining the number of meshes in the thickness of the wall. <b>nm1 must be the same for all segments of the wall.</b>  Two possibilities:  <b>a)</b> The diameters or thicknesses are <u>constant</u> along the segment:  (case of a cylinder wall) : keyword indicating that the diameters are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the diameters of each radial mesh.  (case of a plane wall) : keyword indicating that the thicknesses are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the thickness of each radial mesh: The first value (d1) has no real meaning , it is a reference value; d2 = d1 + thickness_radial_mesh_cell1, etc...
--	---

<sup>1</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be strongly underestimated

<sup>2</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be false (<0.) above 890 °C

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 147/851

or

**b)** The diameters or thicknesses vary linearly along the segment. The diameters or thicknesses at the start and at the end of the segment are then given. Diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by linear interpolation between the values given at the start and end of the segment. The order defining the start and the end of the segment depends on the global definition of the wall (see PRI-AXIS / SECAXIS)

**DINI d11 d21**

...

**dnm11+1**

or

**THINI d11 d21**

...

**dnm11+1 (case of a  
PLANE exchanger)**

**DEND d12 d22**

...

**dnm12+1**

or

**THEND d12 d22**

...

**dnm12+1 (case of a  
PLANE exchanger)**

: keyword followed by nm1+1 real numbers > 0. defining diameters at the start of the segment.

: keyword followed by nm1+1 real numbers > 0. defining thicknesses at the start of the segment.

The first value (d11) has no real meaning ;  
 $d21 = d11 + \text{thickness\_radial\_mesh\_cell1}$ , etc...

: keyword followed by nm1+1 real numbers > 0. defining diameters at the end of the segment.

: keyword followed by nm1+1 real numbers > 0. defining thicknesses at the end of the segment.

The first value (d12) has no real meaning ;  
 $d22 = d12 + \text{thickness\_radial\_mesh\_cell1}$ , etc...

or

**2) ISO nm1**

: keyword indicating that the radial mesh is automatically isovolume. This is followed by an integer > 0 defining the number of meshes in the thickness of the wall. In the present version, **nm1 must be the same for all segments of the exchanger**.

Two possibilities :

**a)** The diameters or thicknesses are constant along the segment :

**DIAM di dext**

: keyword indicating that diameters are constant all along the segment. This is followed by 2 real numbers > 0 defining the internal and external diameters of the wall.

or **THICK di dext**  
(case of a PLANE exchanger)

: keyword indicating that thicknesses are constant all along the segment. This is followed by 2 real numbers > 0.

The first value is a reference value and the second one the first value added to the thickness of the wall.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 148/851

or

**b)** The diameters or thicknesses vary linearly along the segment.  
The diameters at the start and at the end of the segment are then given. The diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by linear interpolation between the values given at the start and end of the segment. The order defining the start and the end of the segment depends on the global definition of the wall (see PRIAXIS / SECAXIS)

**DINI di1 dext1**

: keyword followed by two real numbers  $> 0$ . defining the internal and external diameters at the start of the segment.

or **THINI di1 dext1**  
(case of a PLANE ex-changer)

: keyword followed by two real numbers  $> 0$ .  
The first value is a reference value and the second one the first value added to the thickness of the wall at the start of the segment.

**DEND di2 dext2**

: keyword followed by two 2 real numbers  $> 0$ . defining internal and external diameters at the end of the segment.

or **THEND di2 dext2**  
(case of a PLANE ex-changer)

: keyword followed by two real numbers  $> 0$ .  
The first value is a reference value and the second one the first value added to the thickness of the wall at the end of the segment.

To be  
re-  
peated  
as  
many  
times  
as  
num-  
ber of  
mate-  
rials

To be  
re-  
peated  
as  
many  
times  
as  
num-  
ber of  
seg-  
ments

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i></p>
<b>Document technique DEN</b>	Page 149/851

<p><b>*Heating perimeter</b></p> <p><b>HPERIM</b></p> <p><b>1) POINT</b></p> <p><b>IPp</b></p> <p>or</p> <p><b>perip</b></p> <p><b>2) CONST peri</b></p>	<p>: The heating perimeter will be given in meters. It is always located on the internal side of the wall : the primary side if the keyword given previously was PRIMARY, or the secondary side if the keyword SECONDARY was given.</p> <p>The heating perimeter multiplied by the length of each wall cell will give the heat transfer area between the hydraulic component and the wall.</p> <p>Note that the heating perimeter is given only for the internal side. The external side heat transfer area will be automatically derived from the internal one (both areas will be identical for plane geometry).</p> <p>: keyword indicating that the heating perimeter is to be given.</p> <p>⇒ Two possibilities for entering the heating perimeter :</p> <p>: the heating perimeter is given on certain vector points belonging to the axial meshing of the side which defines the global meshing orientation of the wall (see PRIAXIS / SECAXIS definition). The two vector points on the extremities of the axial hydraulic segment must imperatively be included in the list of vector points entered. This keyword is followed by as many (ipp; perip) pairs as necessary with :</p> <p>: vector point belonging to the axial meshing of the side which defines the global meshing orientation of the wall (see PRIAXIS / SECAXIS definition).</p> <p>: 'mesh'-type object containing a list of vector points having the same heating perimeter and belonging to the axial meshing of the side which defines the global meshing orientation of the wall (see PRIAXIS / SECAXIS definition).</p> <p>: real number <math>&gt;=0</math> defining the heating perimeter on these points. The heating perimeter is located on the primary side if the keyword given previously was PRIMARY, or the secondary side if the keyword SECONDARY was given.</p> <p>The heating perimeters for all the cells located between the 2 vector points on which the heating perimeter has been given will be calculated by linear interpolation between the values of these two points.</p> <p><b>or</b></p> <p>: keyword indicating that the heating perimeter is <b>constant</b> all along the segment. It is followed by a real number <math>&gt;=0</math> defining the heating perimeter on the primary side if the keyword given previously was PRIMARY, or on the secondary side if the keyword SECONDARY was given.</p>	<p><b>To be re-peated as many times as number of materials</b></p> <p><b>To be re-peated as many times as number of segments</b></p>
--	---	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 150/851

Example
---------

```

1) exchan1 = EXCHANGER downcomi steamgen
   PRIMARY CYLINDER
   SEGMENT IS3 IS6 DIRECT
   IP2 IP9
   ACIER533 DATA 2
   DIAM 3.988 4.088 4.478
   HPERIM CONST 235.529 ;

2) exchan2 = EXCHANGER downcomi steamgen
   PRIMARY CYLINDER
   SEGMENT IS3 IS6
   REVERSE IP9 IP16
   MGO ISO 1 DIAM 0 1.d-3
   INOX316 ISO 1 DIAM 1.d-3 2.4d-3
   MGO ISO 1 DIAM 2.4d-3 8.36d-3
   INCON800 ISO 2 DIAM 8.36d-3 9.5d-3
   HPERIM POINT IP9 235.95 IP12 205.8
                  (IP14) AND IP16) 200. ;

3) exchan3 = EXCHANGER downcomi steamgen
   PRIMARY CYLINDER
   SEGMENT IS3 IS6 DIRECT IP2 IP9
   ACIER533 DATA 2 .7766 .8656
   DIAM .7366
   HPERIM POINT
   (IP2 AND IP9) 231.41
   SEGMENT IS3 IS6 REVERSE IP9 IP16
   ACIER533 DATA 2
   DINI .7366 .7766 .8656
   DEND 3.1466 3.2 3.25
   HPERIM POINT
   IP9 231.41 IP16 208.065 ;

```

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 151/851

## 48.2 Quasi implicit exchanger

The **EXCHANGER** operator used with the **IMPLICIT** option allows the definition of heat exchangers involving **AXIAL** or **THREED** elements i.e., an exchanger is defined between :

1. two axial elements,
2. two parts of the same axial element,
3. two parts of the same threed element.

**Warning:** If an exchanger is defined between two axial elements within the same circuit, these elements must be declared in the CIRCUIT respecting the definition of the exchanger.

WRONG	RIGHT
Pipe2 = AXIAL ...; Pipe1 = AXIAL .... ; ... ECH1 = EXCHANGER Pipe2 Pipe1 ...; ... CIRCUIT = ... Pipe2 ... Pipe1...;	Pipe1 = AXIAL ...; Pipe2 = AXIAL .... ; ... ECH1 = EXCHANGER Pipe2 Pipe1 ...; ... CIRCUIT = ... Pipe1... Pipe2...;

The definition of such exchangers is nearly the same as that of explicit exchanger, except that the user must add the **IMPLICIT** keyword as follow:

### 48.2.1 Quasi implicit exchanger on an 1-D element

#### Syntax

**Warning :** DIAM, DINI, DEND keywords are relating to a CYLINDER exchanger, THICK, THINI, THEND are relating to a PLANE exchanger

<b>heax =</b>	<b>EXCHANGER</b> elemesec      elempri <b>PRIMARY</b> (or <b>(PRIAXIS</b> or <b>(MERGE)</b> or <b>CYLINDER</b> or	<b>IMPLICIT</b> <b>SECONDARY)</b> <b>SECAXIS)</b> <b>PLANE )</b>
<b>SEGMENT</b> <b>oblig</b> material1	<b>ISk</b> (or <b>IPi</b> material1	<b>ISn</b> <b>oblig</b> <b>IPj</b>

<b>DATA nm1</b> (or ... or <b>DATA nm1</b>	<b>DIAM</b> <b>THICK)</b> d1 d2 dnm1+1 <b>DINI</b>	     
--	--	-------------

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 152/851

(or <b>THINI</b> ... <b>DEND</b> (or d11 d21 ... <b>THEND</b> )  or <b>ISO</b> nm1 (or di dext  or <b>ISO</b> nm1 (or <b>DINI</b> <b>THINI</b> <b>DEND</b> (or di1 dext1  (material2 <b>HPERIM</b> <b>POINT</b> IP1 IP2 (IP3 and IPj)  or <b>CONST</b> ;  ...	<b>THINI</b> ... <b>DEND</b> (or d12 d22 ... <b>THEND</b> )  <b>ISO</b> nm1 (or di dext  <b>ISO</b> nm1 (or <b>DINI</b> <b>THINI</b> <b>DEND</b> (or di2 dext2  (material2 <b>HPERIM</b> <b>POINT</b> IP1 IP2 (IP3 and IPj)  or <b>CONST</b> ;  ...	d11 d21 dnm11+1  d12 d22 ... dnm12+1  <b>DIAM</b> <b>THICK</b> )  di1 dext1  <b>THEND</b> )  peri1 peri2 peri3  peri	
			<b>To be re- peated as many times as needed</b>

- heax** : name of the exchanger object.  
**elemsec** : name of the axial element representing the secondary side of the heat exchanger.  
**elempri** : name of the axial element representing the primary side of the heat exchanger.  
**NB** : elempri and elemsec can be the same.  
**IMPLICIT** : keyword indicating that a quasi-implicit scheme should be used to solve the heat exchanges from element 'elempri' to element 'elemsec'.  
**Other keywords** : same definition as for exchanger between two circuits.

### 48.2.2 Quasi implicit exchanger on an 3-D element

## Syntax

**Warning :** DIAM, DINI, DEND keywords are relating to a CYLINDER exchanger, THICK, THINI, THEND are relating to a PLANE exchanger

he3d=	<b>EXCHANGER</b>		
	elem3d2	elem3d1	<b>IMPLICIT</b>
	<b>PRIMARY</b>	(or	<b>SECONDARY)</b>
	<b>CYLINDER</b>	(or	<b>PLANE)</b>
	<b>SEGMENT</b>	<b>X</b>	
		(or	<b>Y</b>
		or	<b>Z)</b>
		isdeb	isfin
	or		
	<b>ZONE</b>	zname	
	(or	ideb	ifin
		jdeb	jfin
		kdeb	kfin)
	<b>DIRECT</b>	(or	<b>REVERSE)</b>
		<b>X</b>	(or <b>Y</b>
		or	<b>Z)</b>
		ipdeb	ipfin
	or	zname	
	(or	ideb	ifin
		jdeb	jfin
		kdeb	kfin)
	<b>HSURF</b>		
		<b>CONST</b>	surf
	or	<b>LIST</b>	surf1
		...	surf2
	or	realist_name	surfnn
	material1		
		<b>DATA</b>	nmr
		(or	<b>DIAM</b>
		<b>THICK)</b>	
		d1	d2
		...	dinmr+1
	or		
		<b>DATA</b>	nmr
		(or	<b>DINI</b>
		<b>THINI)</b>	
		dl1	d21
		...	dinmr+1
		<b>DEND</b>	(or
			<b>THEND)</b>
		d12	d22
		...	dinmr+1
	(material2...)	;	

**Remark:** X,Y,Z are generic 3D keywords; they stand for:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 154/851

1. x, y, z directions in Cartesian coordinates,
2. Θ, r, z directions in cylinder coordinates.

<b>he3d</b>	: name of the exchanger object.
<b>elem3d2</b>	: name of the threed element representing the secondary side of the heat exchanger.
<b>elem3d1</b>	: name of the threed element representing the primary side of the heat exchanger.
<b>IMPLICIT</b>	: keyword indicating that a quasi-implicit scheme will be used to solve the heat exchanges from element 'elem3d1' to element 'elem3d2'.
<b>PRIMARY</b> (or) <b>SECONDARY)</b>	: keyword indicating the radial orientation of the exchanger meshing . For a cylinder exchanger, PRIMARY means that the diameters of the wall are increasing from the primary towards the secondary circuit. PRIMARY will be replaced by the keyword SECONDARY if these diameters increase from the secondary towards the primary.
<b>CYLINDER</b>	: keyword indicating that the conduction calculation is to be done in cylindrical geometry.
<b>PLANE</b>	: keyword indicating that the conduction calculation is to be done in plane geometry. <b>If PLANE is used dimension data are radius and not diameters.</b>

#### Exchange column set definition :

<b>SEGMENT</b>	: keyword indicating that a column of exchanger meshes for secondary side is defined by a continuous segment of node, with <b>CATHARE</b> coordinates.	<b>To be re- peated as many times as needed</b>
<b>X</b>	: keyword indicating that the column is orientated by the X direction.	
<b>Y</b>	: keyword indicating that the column is orientated by the Y direction.	
<b>Z</b>	: keyword indicating that the column is orientated by the Z direction.	
<b>isdeb ifin</b>	: integer numbers giving the first and last scalar node of the secondary segment in the selected direction	
<b>ZONE</b>	: keyword indicating that a column of exchanger meshes for secondary side is defined by a scalar zone degenerated to a 1D domain. If the defined zone is wider than a column, an error occurs. It is followed by:	
<b>zname</b>	name of a scalar zone previously defined in MESH directive and limited to a 1D domain for the secondary side.	
or by : <b>ideb ifin</b> <b>jdeb jfin</b> <b>kdeb kfin</b>	: 6 integers for velocity plane numbers for zone definition for secondary side. This zone shall be limited to a 1D domain.	
<b>DIRECT</b>	: keyword indicating that the secondary side of the exchanger has the same count orientation than primary side.	
<b>REVERSE</b>	: keyword indicating that the secondary side of the exchanger has the opposite count orientation than primary side. DIRECT or REVERSE is followed by	
<b>X</b>	: keyword indicating that the column is orientated by the X direction.	
<b>Y</b>	: keyword indicating that the column is orientated by the Y direction.	

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 155/851

<b>Z</b>	: keyword indicating that the column is orientated by the Z direction.
<b>ipdeb ipfin</b>	: integer numbers the first and last scalar node of the primary side segment in the selected direction
<b>zname:</b>	name of a scalar zone previously defined in MESH directive and limited to a 1D domain for the secondary side.
<b>ideb ifin jdeb jfin</b>	6 integers for velocity plane numbers for zone definition for secondary side. This zone shall be limited to a 1D domain.
<b>kdeb kfin</b>	: keyword introducing the exchange surface definition.
<b>HSURF</b>	: keyword indicating that the exchange surfaces are constant on the considered column. It is followed by:
<b>CONST</b>	
<b>surf</b>	: real>0. equal to the exchange surface on the concave side.
<b>LIST</b>	: keyword indicating that the exchange surfaces are given by exchange node on the concave side. It is followed by:
<b>surf1 surf2 ...</b>	: reals>0. corresponding to the exchange surface of the concave side for the considered nodes in the current exchange column set definition. The number of reals is the same as the number of exchanging node on one side
<b>surfn</b>	
<b>realist_name</b>	: name of a REALIST previously defined for the exchange surface definition.  Remark: If the number of nodes on the secondary side is different from the number of nodes on the primary side, an error occurs. The exchange column set definition may be repeated as many times as needed. Anyway, it will refer to the same wall internal radial structure (see below).

#### Wall internal radial structure definition:

<b>material1</b>	: imposed keyword defining the nature of the material used, to select from the following list :	
<b>MGO</b>	Magnesium oxide	
<b>TOPHET<sup>1</sup></b>	Tophet A (Nichrome 5)	
<b>NITRBORE</b>	Boron nitride	
<b>ACIER533</b>	Steel SA533 grade B	
<b>ACIER508</b>	A508 carbon steel	
<b>INOXVES<sup>2</sup></b>	Stainless steel	
<b>INOX304</b>	304 stainless steel	
<b>INOX316</b>	316 stainless steel	
<b>INOX347</b>	347 stainless steel	
<b>INCON600</b>	Inconel 600	
<b>INCON690</b>	Inconel 690	
<b>INCON718</b>	Inconel 718	
<b>INCON800</b>	Inconel 800	
<b>INCON625</b>	Inconel 625	
<b>LOB14948</b>	1.4948 (Lobi Loop)	
<b>CERAMIC</b>	Ceramic (Al <sub>2</sub> O <sub>3</sub> )	
<b>NI201</b>	Ni 201	
<b>LOB14571</b>	1.4571 (Lobi Loop)	
<b>GAP</b>	100% Helium	
<b>ZIRCALOY</b>	zircaloy	

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 156/851

<b>AL2O3</b> XXXXXXi	Al2O3 (Alumin for REBEKA) (i=1,6) user defined material name (FWMAXX subroutine to be defined in the range 28 to 33 ) Name given to a material defined with the MATERIAL operator  <b>NB:</b> Materials will be given in increasing order of diameters (from the primary to the secondary if the keyword given previously was PRIMARY, or from the secondary to the primary if the keyword was SECONDARY).		
<b>*Radial mesh</b>	The radial mesh data (m) will be given in increasing order.		
<b>DATA nm1</b>	: keyword indicating that the radial mesh will be defined mesh by mesh by the user. This is followed by an integer > 0 defining the number of meshes in the thickness of the wall. <b>nm1 must be the same for all segments of the exchanger.</b>  Two possibilities:  <b>a)</b> The diameters or thicknesses are <u>constant</u> along the segment:	<b>To be repeated as many times as number of materials</b>	<b>To be repeated as many times as number of segments</b>
<b>DIAM d1 d2</b> ... <b>dnm1+ 1</b> or <b>THICK d1 d2</b> ... <b>dnm1+ 1 (case of a PLANE exchanger)</b>	: keyword indicating that the diameters are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the diameters of each radial mesh.  : keyword indicating that the thicknesses are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the thickness of each radial mesh: The first value (d1) has no real meaning , it is a reference value; d2 = d1 + thickness_radial_mesh_cell1, etc...	<b>To be repeated as many times as number of materials</b>	<b>To be repeated as many times as number of segments</b>
or	<b>b)</b> The diameters or thicknesses vary linearly along the segment. The diameters or thicknesses at the start and at the end of the segment are then given. Diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by <u>linear interpolation</u> between the values given at the start and end of the segment. The order defining the start and the end of the segment depends on the global definition of the wall (see PRI-AXIS / SECAXIS)		
<b>DINI d11 d21</b> ... <b>dnm11+1</b> or <b>THINI d11 d21</b> ... <b>dnm11+1 (case of a PLANE exchanger)</b>	: keyword followed by nm1+1 real numbers > 0. defining diameters at the start of the segment.  : keyword followed by nm1+1 real numbers > 0. defining thicknesses at the start of the segment.  The first value (d11) has no real meaning ; d21 = d11 + thickness_radial_mesh_cell1, etc...		

<sup>1</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be strongly underestimated

<sup>2</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be false ( $<0$ ) above 890°C

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 157/851

**DEND d12 d22** : keyword followed by nm1+1 real numbers > 0. defining diameters at the end of the segment.  
...  
**dnm12+1**  
or  
**THEND d12 d22** : keyword followed by nm1+1 real numbers > 0. defining thicknesses at the end of the segment.  
...  
**dnm12+1 (case of a PLANE exchanger)** The first value (d12) has no real meaning ;  
d22 = d12 + thickness\_radial\_mesh\_cell1, etc...

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 158/851

49

## EXCPOWER DIRECTIVE

The **EXCPOWER** directive, in *command block*, enables the user to inject heat power inside the walls of a heat exchanger. It becomes effective when called and may be used several times during a computation.

### Associated Keywords

**EXCHANGER**

### Syntax

```
EXCPOWER exchanger
      mat1          ...          matn
      ABSOLUTE
or       RELATIVE    REALIST    list1
      POWER       REALIST    list2
      (PROFILE    REALIST    list3 )
      VOLPOWER   puis_mat1   ...
                           ...           puis_matn ;
```

<b>exchanger</b>	: an exchanger name.
<b>mat1</b>	: a material name of the exchanger or a list of material names if several materials are to be modified with the same power values.
<b>...</b>	
<b>matn</b>	
<b>ABSOLUTE</b>	: keyword specifying that the time origin is time 0. If the time origin is the time when the directive was used, then the keyword <b>RELATIVE</b> should be used.
<b>or RELATIVE</b>	
<b>REALIST</b>	: list of time values (s).
<b>list1</b>	
<b>POWER</b>	: keyword specifying that a list of power multiplying coefficients will be given.
<b>REALIST</b>	: list of power multiplying coefficients function of time
<b>list2</b>	<b>The values are the same all along the exchanger.</b>
<b>PROFILE</b>	: OPTIONAL keyword indicating that the volumic power profile will be given. This keyword is followed by:
<b>REALIST</b>	: list of m real values specifying the axial profile on the m axial wall mesh cells of the heat exchanger; this profile is normalized by the reader.
<b>list3</b>	

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 159/851

**VOLPOWER** : keyword indicating that the volumic power will be given. This keyword is followed by:  
**puis\_mat1** : real numbers defining the volumic power ( $\text{W}/\text{m}^3$ ) imposed for each material.  
**...**  
**puis\_matn**

**NB :**

1. The total thermal power  $PTOT(\text{imat})$  (in W) released in each material is given by :

$$PTOT(\text{imat}) = VOLPOWER(\text{imat}) \cdot \sum_{\text{axialmesh}} [\sum_{\text{radialmesh}} dV(\text{imat})]$$

where VOLPOWER(imat) and dV(imat) represent respectively the volumic power ( $\text{W}/\text{m}^3$ ) provided by the user for material "imat" and the volume of each mesh composing the material layer "imat".

2. The local volumic power values (in  $\text{W}/\text{m}^3$ ) considered by CATHARE, hereafter denoted Pcat(z), are calculated according to the following formula:

$$Pcat(z) = \frac{PTOT(\text{imat}) \cdot Puser(z)}{\sum_{\text{axialmesh}} [\sum_{\text{radialmesh}} Puser(z) dV(\text{imat})]}$$

where the real value list Puser(z) stands for the power profile specified by the user.

<b>Example</b>
----------------

EXCPOWER	exchanger	INCON600	TOPHET
		ABSOLUTE	REALLIST 0. 10.
		POWER	REALLIST 1. 0.
		PROFILE	REALLIST 1. 2. 3. 4. 5. 4. 3. 2. 1.
		VOLPOWER	1.D5 1.D4 ;

EXCPOWER	exchanger	ACIER533	TOPHET
		RELATIVE	REALLIST 0. 10.
		POWER	REALLIST 1. 0.
		PROFILE	REALLIST 1. 2. 3. 4. 5. 4. 3. 2. 1.
		VOLPOWER	1.D5 ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 160/851	

50

## EXHYLINK OPERATOR

The **EXHYLINK** operator creates in *data block* an **EXplicit HYdraulic LINK** between two hydraulics objects (**BC** modules or sub-modules) exchanging mass and energy. The two objects can belong to :

1. the same circuit in a reactor or two circuits coupled via implicit exchangers : they have the same time manager,
2. two different circuits in a reactor coupled via explicit exchangers or in two reactors : they are managed by two differents time manager.

If the two objects are defined in two different circuits within a reactor, the first object must be defined in the circuit declared before the circuit in which the second object is defined.

An EXHYLINK objet is composed of **two hydraulics objects** : a **sink mass and energy term** for the first objet and a **source mass and energy term** for the second objet. Several types of EXHYLINK can be defined. The sink term can be of **external**<sup>1</sup> or of **internal**<sup>2</sup> type when the source term can be only of **external**<sup>1</sup> type.

The **EXHYLINK** operator only defines the link. It must be activated and deactivated by using the **SWITCH** directive.

### 50.1 Communication modes

There are 3 ways for objects to communicate by EXHYLINK depending in the type of the linked objects :

1. The **ONEWAY (and explicit)** communication : The exchange information goes from the first object to the second one.
2. The **TWOWAY (and explicit)** communication : The two objects exchange information between each other. Such a link in a block data is somehow a generalization of the usual link of a explicit **SGTR**.
3. The **IMPLICIT** communications : If the two objects belong to the same time manager (the two objects belong to the same circuit in a reactor or two circuits coupled via implicit exchangers or a **SGTR**), the two objects may exchange information between one and another in a quasi-implicit way. Such a link in a block data is somehow a generalization of the usual link of a implicit **SGTR**.

**At this present**, the **IMPLICIT** communication is **only available** for a sink term of type **PIQBREK** and a source term of type **PIQREV**.

An IMPLICIT communication is forbidden if the two objects do not belong to the same circuits which are explicitly coupled by explicit exchangers or **SGTR**.

<sup>1</sup>External variables are not time-dependent but imposed externally and explicitly (at the beginning of each time step) by the user via the input deck and the CCV

<sup>2</sup>Internal variables are defined by laws with respect to time in the data block. An Interpolation is made as implicit way. The variables are calculated at each iteration of a time step

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 161/851

The exchanged information (see §50.2) is identical in the **TWOWAY** (and explicit) and **IMPLICIT** kinds. The default communication is **TWOWAY** (and explicit).

The use of an explicit EXHYLINK for two objects "implicitly coupled" (in a same circuit or in two circuit implicitly coupled) is not forbidden. But users has to verify at each time step the energy and mass balanced for the two object and manage the time step in order to minimize the energy and mass balance error.

## 50.2 Exchange informations

A reversible EXHYLINK can be defined if the two objets are reversible (**PIQREV**, **PIQBREK**). If the EXHYLINK is **not reversible**, the sink term should be the first objet because it computes the flowrates. The only variable eventually needed to calculate the flowrates is the counter pressure. Two cases are then possible :

1. **The total mass flowrate is imposed by the user** by **CCV** (**external**<sup>3</sup>) or by **LAW** (**internal**<sup>4</sup>). The code doest not need the counter pressure from the second objet. The **ONEWAY** (and explicit) communication is only possible.
2. **The total mass flowrate is calculated by the code**. Two cases are possible :
  - (a) The code needs the counter pressure information from the second objet to calculate the total mass flowrate. The **TWOWAY** (and explicit) or the **IMPLICIT** communications are only possible.
  - (b) The code does not need the counter pressure information from the the second objet to calculate the total mass flowrate. The **ONEWAY** (and explicit) communication is only possible.

In all cases, the code calculates the liquid, vapour, non condensable and radio-chemical component flowrate distribution by taking into account the calculated void fraction, non condensable and radio chemical mass fractions from the sink term to be sent to the source term.

<sup>3</sup>External variables are not time-dependent but imposed externally and explicitly (at the beginning of each time step) by the user via the input deck and the CCV

<sup>4</sup>Internal variables are defined by laws with respect to time in the data block. An Interpolation is made as implicit way. The variables are calculated at each iteration of a time step

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 162/851

## 50.3 Available configurations

The possible configuration are given in the following table :

Second objet		SOURCE	PIQREV
Type		external <sup>5</sup>	external <sup>5</sup>
First objet			
Objet	Type		
SINK	external <sup>5</sup> internal <sup>6</sup>	case 1, not reversible, ONEWAY	case 1, not reversible, ONEWAY
SINKRRI	external <sup>5</sup> internal <sup>6</sup>	case 1, not reversible, ONEWAY	case 1, not reversible, ONEWAY
PIQREV	external <sup>5</sup>	case 1, not reversible, ONEWAY	case 1, reversible, ONEWAY
PIQBREK	external <sup>5</sup>	case 2a, not reversible, TWOWAY	case 2a, reversible, TWOWAY, IMPLICIT
BC4A	external <sup>5</sup>	case 2a, not reversible, TWOWAY	case 2a, not reversible, TWOWAY
RUPTURE	external <sup>5</sup>	case 2a, not reversible, TWOWAY	case 2a, not reversible, TWOWAY

The EXHYLINK object can be used for the coupling between the primary side of a PWR reactor and the containment in case of LOCA. In this case, the reversible PIQBREK-PIQREV EXHYLINK or the RUPTURE-PIQREV or BC4A-PIQREV EXHYLINK's can be used taking into account the assumption of each models.

### Associated Keywords

SWITCH, BCONDIT, RUPTURE, SINK, SOURCE, PIQREV, SOURIS, SINKRRI, BREAK, PIQBREK

### Syntax

```
LINKHY1 =   EXHYLINK  (IMPLICIT)    obj1      obj2
              (ONEWAY)    (EAS        or          ISBP)      ;
```

**LINKHY1** : EXHYLINK name  
**IMPLICIT** : Optional keyword which indicates that the information between the sink and the source will be done by a quasi-implicit way. This option is only available for a sink of type PIQBREK and a source of type PIQREV

**obj1** : Name of the first objet  
**obj2** : Name of the second objet

**(ONEWAY)** : OPTIONAL keyword if the link is ONEWAY type (TWOWAY is the default value)

**(EAS) or**  
**(ISBP)** : If the first object is a SINKRRI with two exchangers (RRI/EAS and RRI/ISBP). This keyword defines which flow (EAS or ISBP) to link to the source sourc1 (refer to SINKRRI operator).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 163/851

<b>Example</b>
----------------

1. Explicit coupling between a rupture and the containment :

```
Rup1 = RUPTURE ... ;  
ASSIGN Rup1 EXTERNAL ... ;  
  
Sourc1 = PIQREV ... EXTERNAL ... ;  
  
Linhyl1 = EXHYLINK Rup1 sourc1 ;
```

2. Explicit coupling between a sinkrri of the containment with two exchangers RRI/EAS and RRI/ISBP and the injections EAS and ISBP :

```
sinri = SINKRRI ... ;  
EAS ... ... ;  
ISBP ... ... ;  
  
Sourceas = SOURCE ... EXTERNAL ... ;  
Sourcisp = SOURCE ... EXTERNAL ... ;  
  
Linhyeas = EXHYLINK Sinri sourceas EAS ;  
Linhyisb = EXHYLINK Sinri sourcisp ISBP ;
```

3. Explicit coupling between a sinkrri of the containment with only one exchanger RRI/EAS and the injection EAS :

```
sinri = SINKRRI ... ;  
RRI ... ;  
  
Source1 = SOURCE ... EXTERNAL ... ;  
  
Linhyeas = EXHYLINK Sinri Source1 ;
```

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<p>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
	<b>Document technique DEN</b>	Page 164/851

# 51

## EXP OPERATOR

The EXP operator calculates the exponential of a number. The result is a real number (DOUBLE)

The EXP directive can be used in both *data* and *command blocks*.

### Associated Keywords

MATHEMATIC, TRIGONOMETRIC, ABSOLUTE, EXP, NEQ, AND, MAX, MIN, OR, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

**z = EXP (x) ;**

### Example

**z = EXP (3.5) ;**

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 165/851</a>

52

## EXWALINK OPERATOR

The **EXWALINK** operator, used in the *data block*, creates an **EXplicit WALL to wall LINK** between two walls. The two wall objects can be of type **WALL** or **FUELPLAQ**, and belong to :

1. the same circuit,
2. two different circuits in a reactor.

The two walls are coupled thermally through this link, and they can exchange heat depending on the solid temperatures in the two walls. The communication is handled automatically by the code. The heat exchanged can be computed using a thermal resistance model (conduction), a simplified radiation model, or a combination of both.

The EXWALINK operator defines the link which must be activated using the **SWITCH** directive after the **GOPERM** directive. The link is not active during the **PERMINIT**.

**N.B. :**

- The link must be defined before the circuit is created.
- It can only connect **WALL** and **FUELPLAQ** objects.
- It cannot be defined for walls belonging to **VOLUME** objects.
- The two walls must have a compatible **1-D** or **3-D** meshing.
- For **3-D** objects, the EXWALINK is available only for Z-direction and IMPLICIT option of EXCHANGER must be used.

For the radiative heat transfer, it is assumed that :

1. the linked walls may be considered of infinite length with respect to their distance;
2. the walls are close enough to consider that the flux losted by one wall is equal to the flux received by the other.  
The model is not able to predict the fluxes exchanged between a small wall inside another one;
3. the walls are “grey walls” so their respective emissivities do not depend on their temperatures.

<b>Associated Keywords</b>
----------------------------

**WALL, FUELPLAQ, SWITCH**

The link is defined on pairs of segments, with one segment belonging to a secondary wall object and the other to a primary wall object. Each segment is defined by two vector points which **must belong** to the axial or **3-D** elements the walls are connected to. The total lengths of these two segments must be equal. The link is symmetrical, so the order of the walls is not important.

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 166/851

The walls must have been previously defined in the *data block*. They may include a heat **SOURCE** term or a heat **LOSS** term. They may also exchange heat through the **TEXT** and **HEXT** keywords.

### Syntax

```
p1 =      EXWALINK    wall_elempri   wall_elemsc
          IMPLICIT    (or
          PRIMARY
          SEGMENT     Isk Isn        MEDIUM      nm1
          DIRECT
          (or
          REVERSE)    Ipi Ipj        MEDIUM      nm2
          HCOEFF
          EMISS       hcoef
                           emiss
                           ;
```

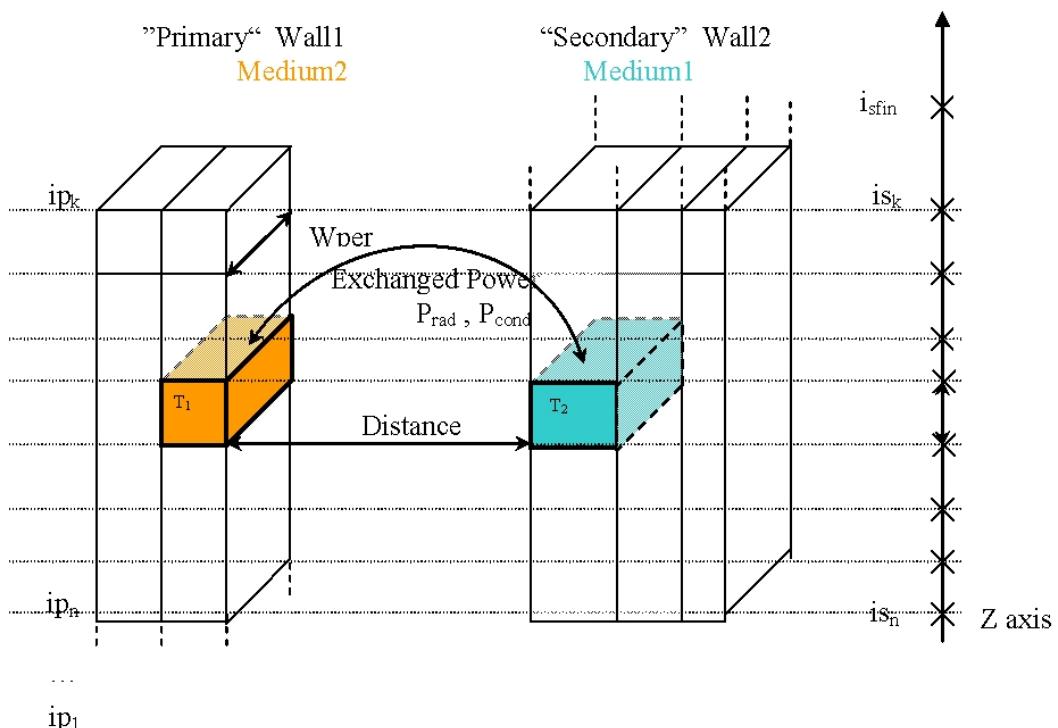
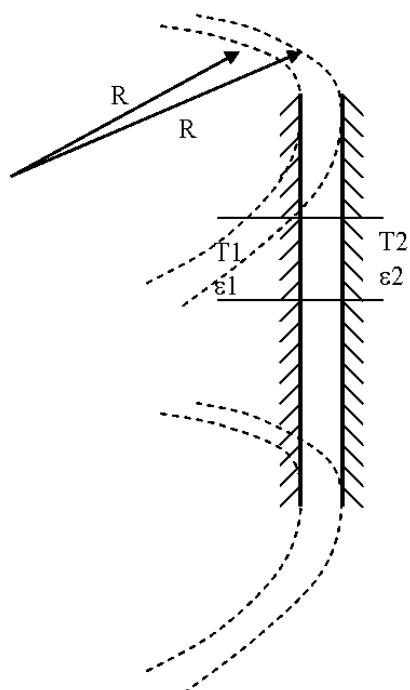


Figure 52.0.1: EXWALINK : Scheme modeling

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
		<b>Document technique DEN</b>

Page 167/851



The radiative-like exchanged power is :

$$P_{\text{rad}} = \text{EMISS} * \sigma * (T_1^4 - T_2^4) = \varepsilon_{\text{equiv}} * W_{\text{per}} * \sigma * (T_1^4 - T_2^4)$$

$$\text{With } \varepsilon_{\text{equiv}} = \varepsilon_1 * \varepsilon_2 / (1 - (1 - \varepsilon_1)(1 - \varepsilon_2))$$

It is an exact formula for 2 plane "grey walls", or a good approximation for cylindrical walls (not necessary of circular sections)

- If  $S_1 \sim S_2$ ,  $\varepsilon_1$  and  $\varepsilon_2$  may be different ( $R_2 - R_1 \ll R_1$ )
- If  $\varepsilon_2 = 1$ ,  $S_2$  may be much lower than  $S_1$

The conduction-like exchanged power is :

$$P_{\text{cond}} = \text{HCOEFF} * \text{Deltz} * (T_1 - T_2) = \lambda_{\text{eff}} * W_{\text{per}} / \text{Distance} * (T_1 - T_2)$$

Here, we choose Distance =  $R_2 - R_1$

Figure 52.0.2: EXWALINK : model

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 168/851

<b>Wall_elempri</b> <b>Wall_elemsec</b>  <b>IMPLICIT</b>  <b>EXPLICIT</b>  <b>PRIMARY</b>  <b>SEGMENT</b>  <b>Isk Ism</b>  <b>MEDIUM nm1</b>  <b>DIRECT (or REVERSE)</b>  <b>Ipi Ipj</b>  <b>MEDIUM nm2</b>  <b>HCOEFF hccoeff</b>	<p>: primary wall of the link. (Wall1)          : secondary wall of the link. (Wall2)</p> <p>: use IMPLICIT when walls belong to the same time manager (i.e. one circuit or two circuits with no EXPLICIT mention in REACTOR directive or two circuits coupled by IMPLICIT type heat exchangers),          : use EXPLICIT when walls belong to two time managers (i.e. two circuits linked in a REACTOR with the EXPLICIT statement or involving non IMPLICIT heat exchangers).</p> <p><b>There is for the moment no effect on the resulting computation.</b></p> <p>: keyword indicating that the following statements refer to the meshing of the primary wall.</p> <p>: keyword indicating that two pairs of points are to be read, defining the wall segments to be linked. One pair of points belongs to the “elempri” axial element connected to the primary wall, the other to the “elemsec” axial element connected to the secondary wall.          The keyword is followed by:</p> <p>: vector points which <b>must</b> belong to the axial mesh of the primary element and which define the start and end of the exchange zone. These two points must be given in the order in which the primary hydraulic mesh has been defined.</p> <p>: keyword indicating the medium (material layer) of the wall <b>Wall_elempri</b> (Wall1) to be used for the coupling.          Integer which identifies the layer which receives the exchanged power. The average temperature in this layer is used for the calculation of the exchange.</p> <p>: keyword preceding the pair of points of the secondary element, when primary and secondary meshes are described in the same direction.          DIRECT is replaced by REVERSE when primary and secondary meshes are described in opposite directions.</p> <p>: vector points which <b>must</b> belong to the axial mesh of the secondary element and which define the start and end of the exchange zone. These two points must be given in the order in which the secondary hydraulic mesh has been defined.</p> <p>: keyword indicating the medium (material layer) of the wall <b>Wall_elemsec</b> (Wall2) to be used for the coupling.          : Integer which identifies the layer which receives the exchanged power. The average temperature in this layer is used for the calculation of the exchange.</p> <p>: coefficient of conductive coupling used by the link. The unit is W/m/°C (power per °C and unit axial length).          The exchanged power in the figure is Pcond.          For the example in the figure, HCOEFF has to be calculated as  <math display="block">HCOEFF = \lambda_{eff} \cdot \frac{W_{per}}{Distance}</math> <math display="block">\lambda_{eff} = \text{effective conductivity (W/m/°C)}</math> <math display="block">W_{per} = \text{perimeter of the exchange interface (m) (the width of the walls for example in plane geometry)}</math> <math display="block">\text{Distance} = \text{characteristic distance (m) between the two solids (Wall1 Wall2)}</math> <math display="block">\text{These parameters have to be fitted by the user.}</math> </p>
---	---

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 169/851

**EMISS emiss** : Coefficient of radiative coupling used by the link. The unit is meter, because EMISS is the product of a non-dimensional emissivity and of the interface perimeter  $W_{per}$  !  
The exchanged power in the figure is  $P_{rad}$ .  
For the example in the figure, EMISS has to be calculated as  

$$EMISS = \epsilon_{equiv} \cdot W_{per}$$
  
 $\epsilon_{equiv}$  = radiative coupling coefficient between the two walls. It is an equivalent emissivity (dimensionless) (may also take into account a form factor).  
 $W_{per}$  = perimeter of the exchange interface (m) (the width of the walls for example in plane geometry)  
These parameters have to be fitted by the user.

### Example

```

WAL1 = WALL PIPE1 EXTERNAL PLANE
SEGMENT GBYP01 GBYP03
INOX316
DATA 2 THICK 0.0100 0.0104 0.0108
INOX304
DATA 1 THICK 0.0108 0.0112
ACIER508
DATA 2 THICK 0.0112 0.0116 0.0120
HPERIM POINT (GBYP01 AND GBYP03) 3.14159E-2
SOURCE MEDIUM 2 LAW LOIPUSS VOLPOWER 2.D5 ;
*
```

```

WAL2 = WALL PIPE2 EXTERNAL PLANE
SEGMENT IGBYP01 IGBYP03
INOX316
DATA 5 THICK 0.0100 0.0104 0.0108 0.0112 0.0116 0.0120
HPERIM POINT (IGBYP01 AND IGBYP03) 3.14159E-2 ;
```

```

*
WIIPIP1 = WALL IIPIPE1 EXTERNAL PLANE
SEGMENT IIGBYP01 IIGBYP03
INOX316
DATA 5 THICK 0.0100 0.0104 0.0108 0.0112 0.0116 0.0120
HPERIM POINT (IIGBYP01 AND IIGBYP03) 3.14159E-2
LOSS PHIEXT 0. ;
```

```

*
PAROI1 = EXWALINK WAL1 WAL2 IMPLICIT
PRIMARY SEGMENT GBYP01 GBYP03 MEDIUM 2
DIRECT IGBYP01 IGBYP03 MEDIUM 1 HCOEFF 0.8D0 EMISS 1.D-2 ;
PAROI2 = EXWALINK WAL1 WIIPIP1 IMPLICIT
PRIMARY SEGMENT GBYP01 GBYP03 MEDIUM 3
DIRECT IIGBYP01 IIGBYP03 MEDIUM 1 HCOEFF 5.D-2 EMISS 0. ;
PAROI3 = EXWALINK WAL2 WIIPIP1 IMPLICIT
PRIMARY SEGMENT IGBYP01 IGBYP03 MEDIUM 1
DIRECT IIGBYP01 IIGBYP03 MEDIUM 1 HCOEFF 0.8D0 EMISS 0. ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 170/851

53

## FASTSIZE DIRECTIVE

The **FASTSIZE** directive defines the memory space allocated to **CATHARE** data structure in order to store variables. It modifies the local FAST.H include file which is used by the UNIX procedure “cathar.unix” or DOS procedure “catharf.bat” when building a new **CATHARE** executable. This operator can be used in the *data block* or in the *command block* before RESTORE directive.

### Associated Keywords

**OPTION, VERBOSE, RESETIME, RESTORE, SAVE, INISIM, MANAGE**

### Syntax

<b>FASTSIZE</b>	<b>DOUBLE</b>	<code>lengthd</code>	
	<b>INTEGER</b>	<code>lengthi</code>	
	<b>CHAR8</b>	<code>lengthc</code>	;

<b>DOUBLE</b>	<b>lengthd</b>	: Keyword followed by an integer > 0 used to define the maximum number of double precision variables stored in <b>CATHARE</b> data structure for a calculation. The default value is 9 500 000.
<b>INTEGER</b>	<b>lengthi</b>	: Keyword followed by an integer > 0 used to define the maximum number of integer variables stored in <b>CATHARE</b> data structure for a calculation. The default value is 1 800 000.
<b>CHAR8</b>	<b>lengthc</b>	: Keyword followed by an integer > 0 used to define the maximum number of CHARACTER*8 variables stored in <b>CATHARE</b> data structure for a calculation. The default value is 1 700 000.

### Example

```
FASTSIZE      DOUBLE      10000000      INTEGER      1800000      CHAR8       1500000 ;
```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 171/851</a>

54

## FLOMIXER OPERATOR

The **FLOMIXER** operator, used in the *data block*, creates a ‘FLOMIXER’-type object between two no adjacent *volume* elements. This object defines an incomplete mixture model.

The **FLOMIXER** operator only defines and locates the FLOMIXER object, **it does not enable it** (see **STAR MIX**, **STOP MIX**).

The **FLOMIXER** model can be used in the vessel to take into account the imbalance of the temperatures at the vessel inlets and to carry it at the vessel outlets without changing the core calculation. It must be used when primary pumps are in use and when the flowrates in the loops are not too different.

### Associated Keywords

**VOLUME, STARTMIX, STOPMIX**

### Syntax

```
mixer_name= FLOMIXER N
      FROM volumin_name juncin1      juncin2      ...      juncinN
      TO   volumou_name juncou1      juncou2      ...      juncouN
      N4   or          CP1          or          ...
      USER  om1         om2         ...         omN
      AGMAX z1
      DQMAX z2         ;
```

<b>mixer_name</b>	: flomixer type object.
<b>N</b>	: Number of ports involved in the incomplete mixture model for each volume.
<b>FROM</b>	: Keyword preceding the name of the incoming volume.
<b>volumin_name</b>	
<b>juncin1</b>	: Names of the ports of the incoming volume involved in the mixture model.
<b>juncin</b>	
<b>...</b>	
<b>juncinN</b>	
<b>TO</b>	: Keyword preceding the name of the outgoing volume.
<b>volumou_name</b>	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 172/851

**juncou1 juncou** : Names of the ports of the outgoing volume involved in the mixture model. These junctions must be in the same order as the ports of the incoming volume.  
**...**  
**juncouN**

**N4** : Keyword giving the repartition coefficient of the mixture model  
**or CP1**  
**or USER**  
**om1 om2**  
**...omN** If the keywords N4 or CP1 are used, the coefficients are defined in **CATHARE** library.  
If the keyword USER is given, it must be followed by N coefficients such that :  
 $om1 + om2 + \dots + omN = 1$   
 $omi > 0 \ (i=1,2,\dots,N)$

**AGMAX z1** : Keyword followed by a real between 0 and 1 giving the maximal value of void fraction for which the incomplete mixture model can be applied.  
**DQMAX z2** : Keyword followed by a real between 0 and 1 giving the maximal value of the asymmetry coefficient between incoming flowrates for which the incomplete mixture model can be applied.

### Example

```

MELANGE= FLOMIXER    4
          FROM        voldown      downin1     downin1     downin3     downin4
          TO   volsup    supintac1  supintac2  supintac3  supintac4
          N4
          AGMAX      1.D-1       DQMAX      1.D0 ;

```

```

MELANGE= FLOMIXER    2
          FROM        voldown      downromp    downint
          TO   volsup    suprompu   supintac
          USER        0.60D0    0.40D0
          AGMAX      1.D-1       DQMAX      1.D0 ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 173/851</a>

55

## FLOMIXER ZOOM OPERATOR

The **FLOMIXER ZOOM** operator, used in the *data block*, creates a ‘FLOMIXER ZOOM’-type object between two *volume* elements involved in a reactor vessel description. This object defines an incomplete mixture model. It has to be used with the objects of type GROUP: JUNCTION, PIPE and BCONDIT describing the detailed core hydraulics (Zoom Core).

The **FLOMIXER ZOOM** operator only defines and locates the FLOMIXER object; it does not enable it (see **STAR MIX**, **STOP MIX**). The **READ MIX** directive of the *exe block* has to be used with the **FLOMIXER ZOOM** operator.

### Associated Keywords

**STAR MIX**, **STOP MIX**, **READ MIX**

### Syntax

```

mixer_name= FLOMIXER ZOOM N
              LOWRPLEN volumin_name INLET juncin1 ...
                               OUTLET juncou1 ...
                               LINKTO BCONDIT bcondit_name
                               LINKTO PIPE pipe_name
                               (OUTLET juncou2 ... )
                               UPPRPLEN Volumou_name OUTLET juncou1 ...
                               INLET Juncin1 ...
                               LINKTO BCONDIT bcondit_name
                               LINKTO PIPE pipe_name
                               (INLET juncin2 ... )
AGMAX      z1
DQMAX      z2
FILENAME   file_name ;

```

**mixer\_name** : name of the flomixer zoom type object.  
**N** : Number of flow mix involved in the incomplete mixture model for each volume.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 174/851

<b>LOWRPLEN</b> volumin_name	: name of the incoming volume.
<b>INLET</b> juncin1 ... juncinn	: name of the inlet ports of the incoming volume involved in the mixture model
<b>OUTLET</b> juncou1	: name of the first outlet port of the incoming volume involved in the mixture model.
<b>LINKTO</b> <b>BCONDIT</b> bcondit_name	: name of a boundary condition object of type GROUP (inlets of the Zoom Core description). <b>Warning :</b> The boundary condition must be of type BC3 EXTERNAL
<b>LINKTO</b> <b>PIPE</b> pipe_name	: name of a pipe of type GROUP (Zoom Core hydraulic channels).
<b>UPPRPLEN</b> volumou_name	: name of the outgoing volume.
<b>OUTLET</b> juncou1 ... juncoun	: names of the outlet ports (hot legs) of the outgoing volume involved in the mixture model. These junctions must be in the same order as the ports of the incoming volume.
<b>INLET</b> juncin1	: name of the first inlet port of the outgoing volume involved in the mixture model.
<b>LINKTO</b> <b>BCONDIT</b> bcondit_name	: name of a boundary condition object of type GROUP (outlets of the Zoom Core description). <b>Warning :</b> The boundary condition must be of type BC5 EXTERNAL
<b>LINKTO</b> <b>PIPE</b> pipe_name	: name of a pipe of type GROUP (Zoom Core hydraulic channels).
<b>AGMAX</b> z1	: real between 0 and 1 giving the maximum value of void fraction for which the incomplete mixture model can be applied.
<b>DQMAX</b> z2	: real between 0 and 1 giving the maximal value of the asymmetry coefficient between inlet flowrates for which the incomplete mixture model can be applied.
<b>FILENAME</b> file_name	: name of an external file from which the coefficients of repartition of the mixture will be read. (refer to READMIX directive) ; the filename can be up to 8 characters long (without the .dat default extension) <sup>1</sup>

<sup>1</sup>**WARNING:** Be careful that the tabulation character is forbidden in this file.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 175/851

**Example**

First, the objects of type GROUP have to be defined:

BOTA = JUNCTION GROUP 6 SUFFIX 1 WEIGHT CONST 6908 ;

TOPA = JUNCTION GROUP 6 SUFFIX 1 WEIGHT CONST 6908 ;

\*

BOTB = JUNCTION GROUP 1 SUFFIX 1 WEIGHT CONST 1 ;

TOPB = JUNCTION GROUP 1 SUFFIX 1 WEIGHT CONST 1 ;

\*

ENTA = BCONDIT GROUP BOTA DSTREAM ;

MODEL ENTA BC3 EXTERNAL

HLIQEXT 1230.D3

OVERHEAT 0.1D0

ALFAEXT 1.0D-5

GAMEXT 1.0D0

QTEXT 0.3267D0 ;

\*

ENTB = BCONDIT GROUP BOTB DSTREAM ;

MODEL ENTB BC3 EXTERNAL

HLIQEXT 1230.D3

OVERHEAT 0.1D0

ALFAEXT 1.0D-5

GAMEXT 1.0D0

QTEXT 6.65D2 ;

\*

CANA = AXIAL GROUP TEMPLATE MIDCORE BOTA USTREAM TOPA DSTREAM ;

CANB = AXIAL GROUP TEMPLATE BYPASS BOTB USTREAM TOPB DSTREAM ;

\*

SORA = BCONDIT GROUP TOPA USTREAM ;

MODEL SORA BC5A EXTERNAL

PEXT 159.266D5 ;

\*

SORB = BCONDIT GROUP TOPB USTREAM ;

MODEL SORB BC5A EXTERNAL

PEXT 159.03571D5 ;

Then, the FLOMIXER ZOOM can be defined as follow:

<b>MANTA =</b>	<b>FLOMIXER</b>	<b>ZOOM</b>			
	<b>LOWRPLEN</b>	<b>LWPLEN</b>	<b>INLET</b>	<b>DOWNLWP1</b>	<b>DOWLWP2</b>
			<b>OUTLET</b>	<b>MIDLWP</b>	<b>DOWNLWP3</b>
			<b>LINKTO</b>	<b>BCONDIT</b>	<b>ENTA</b>
			<b>LINKTO</b>	<b>PIPE</b>	<b>CANA</b>
			<b>OUTLET</b>	<b>BYPASLWP</b>	
			<b>LINKTO</b>	<b>BCONDIT</b>	<b>ENTB</b>
			<b>LINKTO</b>	<b>PIPE</b>	<b>CANB</b>
<b>UPPRPLEN</b>		<b>UPPLEN</b>	<b>OUTLET</b>	<b>CHAUDE1</b>	<b>CHAUDE2</b>
			<b>INLET</b>	<b>MIDUPP</b>	<b>CHAUDE3</b>
			<b>LINKTO</b>	<b>BCONDIT</b>	<b>SORA</b>
			<b>LINKTO</b>	<b>PIPE</b>	<b>CANA</b>

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 176/851

INLET            BYPASUPP  
LINKTO          BCONDIT       SORB  
LINKTO          PIPE           CANB

**AGMAX**        1.D-1  
**DQMAX**        1.D0

**FILENAME**    FICH2        ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 177/851

56

## FLOW-LIMITER OPERATOR

The **FLOW LIMITER** operator used in the *data block* creates a **FLOW LIMITER** type object.

The **FLOW LIMITER** can be located either on a current vector mesh of an axial element, or between two elements. Junctions must be of type **[1-D-0-D]** or **[1-D-TEE]**.

The **FLOW LIMITER** operator only defines and locates the flow limiter. To connect or disconnect the flow limiter refer to the **ENABLE** and **DISABLE** directives.

### Associated Keywords

**ENABLE**, **DISABLE**, **VALUE FOR VALVE**, **WRITE FOR VALVE**

### Syntax

elem =	<b>FLOW</b>	<b>LIMITER</b>	<b>POINT</b>	<b>pipe1</b>	<b>pvect1</b>
		or	<b>JUNCTION</b>	<b>elem1</b>	<b>elem2</b>
		( <b>RO</b>	roref		
		<b>CV</b>	cvref )		
		<b>SR</b>	sect	;	

<b>elem</b>	: name of the flow-limiter (maximum of 7 characters in case of location at a junction)
<b>POINT</b>	: keyword indicating that the flow-limiter is located on an internal mesh of an axial element.
<b>pipe1</b>	: name of the pipe
<b>pvect1</b>	: name of the vector point where the flow-limiter is located.
<b>JUNCTION</b>	: keyword indicating that the flow-limiter is located at a junction between a volume or a tee and an axial.
<b>elem1</b>	: name of the volume or the tee
<b>elem2</b>	: name of the axial
<b>RO roref</b>	: OPTIONAL keyword followed by a real roref > 0. roref is the reference fluid density for the valve specifications (kg/m <sup>3</sup> ) <ul style="list-style-type: none"> <li>- If roref ≤ 500 kg/m<sup>3</sup>, the capacity is supposed to be defined in critical steam flow condition</li> <li>- If roref &gt; 500 kg/m<sup>3</sup>, the capacity is supposed to be defined in sub-critical liquid flow condition</li> </ul>

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 178/851

**CV cvref** : OPTIONAL keyword indicating that the normalized flow-limiter capacity is to be read. This is followed by a real  $> 0$ .

**SR sect** : mandatory keyword followed by a real  $> 0$ . sect is the reduced surface of the flow limiter.

When the RO keyword is used, the CV keyword is mandatory and reciprocally.

When the option (RO and CV) is used, CATHARE2 computes the head loss as a function of the flow-limiter capacity. The reduced surface is only used to compute the cross momentum equation.

If the option (RO and CV) is not used, CATHARE2 automatically computes the corresponding head loss coefficient using SR and an internal law. The reduced surface is used to compute the cross momentum equation.

When The RO keyword is used and for  $\text{roref} \leq 500 \text{ kg/m}^3$  (the capacity is supposed to be defined in critical steam flow condition), SR is used for calculating the critical flow rate.

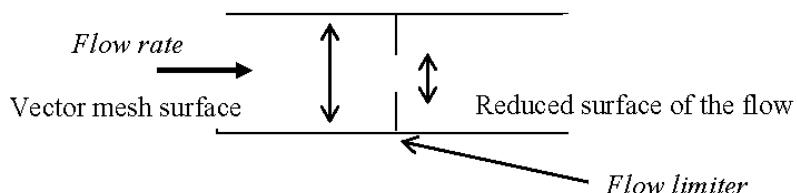


Figure 56.0.1: FLOW LIMITER : configuration

### Example

```

pvp1 =      VECTOR      tuyvap1    42.9      ;  

vpi1 =      FLOW        LIMITER    POINT      tuyvap1      pvp1  

              SR          0.35D-2  ;  

vpi2 =      FLOW        LIMITER    JUNCTION   cavite2      tuyvap2  

              RO          1.D0  

              CV          27125.D0  

              SR          0.6D0      ;

```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 179/851

57

## FLUID OPERATOR

The **FLUID** operator, used in *data block* only, defines the main fluid to be used in the two-fluid model of **CATHARE**. It is specified during the construction of the circuit (see **CIRCUIT** operator). This main fluid can be used along with non-condensable gases.

*The maximum number of fluids is 10 .*

**BEWARE :** In case of 2 circuits, if a SGTR operator is connected during the calculation or if the circuits are implicitly coupled, the FLUID operator has to be the same for both circuits. In other cases, each circuit can deal with a different FLUID.

Acquisition of FLUIDs can be done only one time for two circuits if they are the same but they will have to be declared in the two circuit operators.

### Associated Keywords

**CIRCUIT, MONOPHAS(E)**

### Syntax

```
fluid_prim=    FLUID      fluidname      (TABLES);
```

**fluid\_prim** : name of the FLUID which will be used in the building of the CIRCUIT.

**FLUID** : keyword followed by

**fluidname** : keyword that may have any of the following values :

**WATER** : the fluid is water H<sub>2</sub>O, this is the default value for **CATHARE**  
This is equivalent to specifying no FLUID.

or **IAPWSWAT** : the fluid is WATER, but the IAPWS-IF97 water and steam tables with specific closure laws for supercritical water are used.

or **HEAVYWAT** : the fluid is heavy water DHO.

or **HIGHXNC** : the fluid is WATER, but some adaptations are taken into account for high non-condensable gas mass fractions encountered in gas cooled reactors.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 180/851

- or **SODIUM** : the fluid is sodium
- or **HYDROGEN** : the fluid is H2
- or **LEAD** : the fluid is LEAD
- or **LEADBISM** : the fluid is LEAD BISMUTH
- TABLES** : Optional keyword for standard defined fluids to indicate that the thermodynamic functions will be calculated from tables defined outside **CATHARE**.  
                   : Mandatory keyword for user defined fluids FLUSER1 to FLUSER5

<b>Examples</b>
-----------------

```

1) i1      = FLUID    HIGHXNC    ;
2) i2      = FLUID    WATER      ;
3) i3      = FLUID    HYDROGEN  TABLES ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 181/851

58

## FLUMOD DIRECTIVE

The **FLUMOD** directive is used to modify the heat exchange conditions of a wall with the outside during the computation. These conditions are initially defined in the wall data (see WALL operator). The new values (convective heat transfer coefficient, radiative heat transfer coefficient, flux heat transfer coefficient with the external side and external temperature) are given.

The **FLUMOD** directive is used in *the command block*.

### Associated Keywords

**WALL, WALL3D, ADIABWAL, POWER, RADIAT**

### Syntax

#### Case 1

```
FLUMOD    wall1      text1      hext1
              (EXTEND   ind1
                           eext1      phiext1 )      ;
```

#### Case 2

```
FLUMOD    wall1      REALIST   text1...      textj...      textn
              (EXTEND   REALIST   hext1...      hextj...      hextn
                           ind1
                           REALIST   eext1...      eextj...      eextn
                           REALIST   phiext1...  phiextj...  phiextn);
```

<b>wall1</b>	: name of the wall
<b>text1</b>	: real number representing the new external temperature (°C).
	If the value -999. is used, the external temperature will remain unchanged.
<b>text1 ...</b>	: list of real numbers representing the new external temperature (°C) on mesh number j of the wall, whose total mesh number is n.
<b>textj ... textn</b>	If the value -999. is used, the external temperature will remain unchanged.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 182/851

<b>hext1</b> <b>hext1 ...</b> <b>hextj ... hextn</b>  <b>EXTEND</b> <b>ind1</b>	: real number representing the new heat transfer coefficient (W/m <sup>2</sup> /°C). If the value -999. is used, the heat transfer coefficient will remain unchanged.  : list of real numbers representing the new heat transfer coefficient (W/m <sup>2</sup> /°C) on mesh j of the wall, whose total mesh number is n. If the value -999. is used, the heat transfer coefficient will remain unchanged.  : OPTIONAL keyword which sets the active modes of heat transfer : integer representing the heat transfer index. -Ind1 = 1 : Convective heat transfer -Ind1 = 2 : Flux heat transfer -Ind1 = 4 : Radiative heat transfer -Ind1 = 5 : Convective and radiative heat transfer -Ind1 = 6 : Flux heat transfer and radiative heat transfer
<b>eext1</b> <b>eext1 ...</b> <b>eextj ... eextn</b>	: real number representing the new non-dimensional surface emissivity used for radiation heat transfer. If the value -999. is used, the emissivity will remain unchanged. : list of real numbers representing the new non-dimensional surface emissivity used for radiation heat transfer on mesh j of the wall, whose total mesh number is n. If the value -999. is used , the emissivity will remain unchanged .
<b>phiext1</b> <b>phiext1 ...</b> <b>phiextn</b>	: real number defining the exchange flux [W/m <sup>2</sup> ]. The flux is lost by the wall if ( $\varphi_{ext} < 0.$ ) and received if ( $\varphi_{ext} > 0.$ ). If the value -1.D99 is used, the heat flux will remain unchanged. : list of real numbers representing the new heat flux on mesh j of the wall, whose total mesh number is n. The flux is lost by the wall if ( $\varphi_{ext} < 0.$ ) and received if ( $\varphi_{ext} > 0.$ ). If the value -1.D99 is used , the heat flux will remain unchanged .

In case 1, the same Text1, Hext1, Eext1 or Phiext1 are imposed on all meshes of the wall.

In case 2, the number of values in both lists has to be equal to the total mesh number of the wall. Different Textj, Hextj, Eextj or Phiextj from one mesh to the other are imposed.

**NB 1:** The outside is either a “black body” and in that case, the emissivity to be given is the emissivity of the wall. If the user requires a “grey body” for the outside, the emissivity value must then be considered as an equivalent emissivity including eventual form factor and effect of differential emissivities between the wall and the outside, which are both considered to be grey bodies. The appropriate correction and limitations are described in the EXWALINK operator.

**NB 2:** The corresponding FORTRAN subroutine called in PILOT is either:

**Case 1 :**

1/ MODFLU. The arguments are the following ones : CALL MODFLU (OBJNAM, TEXT, HEXT, \*9999)

OBJNAM	CHARACTER*8 name of the WALL
TEXT	DOUBLE PRECISION value of the new external temperature
HEXT	DOUBLE PRECISION value of the new heat transfer coefficient

2/ MODEFLU, when **EXTEND** option is used. The arguments are the following ones : CALL MODEFLU (OBJNAM, INDEX,TEXT, HEXT, EEXT, PHIEXT, \*9999)

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 183/851

OBJNAM	CHARACTER*8 name of the WALL
INDEX	INTEGER value of the heat transfer index
TEXT	DOUBLE PRECISION value of the new external temperature
HEXT	DOUBLE PRECISION value of the new convective heat transfer coefficient
EEXT	DOUBLE PRECISION value of the new surface emissivity
PHIEXT	DOUBLE PRECISION value of the new heat flux

#### Case 2 :

1/ MODFLV. The arguments are the following ones : CALL MODFLV (OBJNAM, NVAL, RVAL, \*9999)

OBJNAM	CHARACTER*8 name of the WALL
NVAL	INTEGER length of arrays TEXT and HEXT
RVAL	DOUBLE PRECISION array for : <ul style="list-style-type: none"> <li>- TEXT, the new external temperatures (NVAL first values)</li> <li>- and HEXT, the new heat transfer coefficients (values from NVAL+1 to 2*NVAL)</li> </ul>

2/ MODEFLV, when **EXTEND** option is used. The arguments are the following ones : CALL MODEFLV (OBJNAM, INDEX, NVAL, RVAL, \*9999)

OBJNAM	CHARACTER*8 name of the WALL
INDEX	INTEGER value of the heat transfer index
NVAL	INTEGER length of arrays TEXT, HEXT, EEXT and PHIEXT
RVAL	DOUBLE PRECISION array for : <ul style="list-style-type: none"> <li>- TEXT, the new external temperatures (NVAL first values)</li> <li>- HEXT, the new convective heat transfer coefficients (values from NVAL+1 to 2*NVAL)</li> <li>- EEXT, the new surface emissivities (values from 2*NVAL+1 to 3*NVAL)</li> <li>- PHIEXT, the new heat fluxes (values from 3*NVAL+1 to 4*NVAL)</li> </ul>

#### Examples

```

FLUMOD WC03 90.D0 20.D0 ;
FLUMOD WC03 90.D0 5.D0 EXTEND 1 0.D0 0.D0 ;
FLUMOD WC03 -999.D0 7.D0 EXTEND 1 0.D0 0.D0 ;
FLUMOD WC03 0.D0 0.D0 EXTEND 2 0.D0 1.0D4 ;
FLUMOD WC03 0.D0 0.D0 EXTEND 2 0.D0 -1. D99 ;
FLUMOD WC03 90.D0 0.D0 EXTEND 4 0.8D0 0.D0 ;
FLUMOD WC03 90.D0 5.D0 EXTEND 5 0.8D0 0.D0 ;
FLUMOD WC03 90.D0 0.D0 EXTEND 6 0.8D0 1.D3 ;

```

59

## FUEL3D OPERATOR

The **FUEL3D** operator is an extension of the standard FUEL operator designed for the three dimensional hydraulic module.

The **FUEL3D** operator is used to define fuel rods with **UO<sub>2</sub>** pellets on a three dimensional hydraulic element. The **FUEL3D** operator is used in the *data block*.

The **FUEL3D** operator creates an elementary fuel object connected to a three dimensional element and defines its characteristics. The object thus defined will be included in the computation only after it has been integrated (see **INTEGRATE**).

If the **NEUTRO** option of the **FUEL3D** operator is used then the **NEUTRO** option of the **FUELCHAR** operator must be used too. If the **NEUTRO** option of the **FUEL3D** operator is used, it has to come before the **CORE** operator, which also has to be used.

The **FUEL3D** object is defined on segments defined by pairs of scalar meshes of the 3D element. All the meshes of a FUEL3D element must belong to the same column. A mesh **cannot be repeated** within a fuel3D object. The fuel3D object contains all the segments to be **INTEGRATED** together.

If several **FUEL3D** objects are needed, they all have to be defined **along the same coordinate axis**.

### Associated Keywords

AND FUELCHAR FUEL3D GOEUEL INTEGRATE POWER VALUE FOR 3D FUEL WRITE FOR 3D FUEL

---

## Syntax



 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 186/851

```

...
valdzn      valpn)
nk          valpk
:
DOPPLER   PROFILE
ni          valpi
(NDATA
valdzj      valj
...
valdzn      valpn)
nk          valpk
:
);

```

- elem1** : three dimensional hydraulic element.  
**INTERNAL SEGMENT** : keyword to indicate that the fuel wall is necessarily within the flow.  
: keyword to indicate that at least one segment on which a fuel wall is to be defined, is going to be read. It is followed by as many pairs of points as required.  
**(X or Y or Z)** : coordinate axis along which the FUEL3D element is to be defined. Default value : Z.  
**ni nj** : Pair of three dimensional hydraulic meshes (referring to scalar absolute numbering) : this defines the beginning and end of the segment. These meshes **must** belong to the same column of the 3D element.

#### Radial meshing (see CATHARE2 user manual for more explanations)

The diameters will be given in increasing order (m). The diameters are constant along the segment. The radial mesh of the fuel wall can be entered in one of the two following ways :

- DATA nm1** : keyword to indicate that the radial meshing is to be **defined mesh by mesh**. This is followed by an integer > 0 defining the number of elementary radial meshes  
**DIAM d1 d2 ... dnm1+1** : keyword to indicate that the diameters are constant along the segment. This is followed by nm1+1 real numbers > 0. defining the diameter of each radial mesh.

**Note** : The first diameter d1 corresponds to the inside diameter of the **UO<sub>2</sub>** (in order to be able to define the diameter of the hole in the middle of the fuel rod), the last diameter dnm1+1 corresponds to the outside diameter of **UO<sub>2</sub>** ; both are initial values for thermomechanic calculation.

or

- ISO nm1** : keyword to indicate that the radial meshing is **automatically isovolume**. It is followed by an integer > 0 defining the number of elementary meshes in the wall thickness.  
**DIAM dio duo2** : keyword to indicate that the diameters are constant along the segment. It is followed by two real numbers > 0. defining the inside and outside diameters of the wall.

**Note** : The first diameter dio corresponds to the inside diameter of **UO<sub>2</sub>** (to be able to define the diameter of the hole in the middle of the fuel rod), the last diameter duo2 corresponds to the outside diameter of UO<sub>2</sub> ; both are initial values for

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 187/851

thermomechanic calculation.

## **U02 Characteristics**

**UO2** : keyword to indicate that the fuel characteristics are going to be defined.

There are two possible ways for defining the characteristics of the **UO<sub>2</sub>** fuel pellet :

**NEWFUEL** or **IRRxFUEL** : keyword defining a new **UO<sub>2</sub>** pellet : keyword defining an irradiated (used) **UO<sub>2</sub>** pellet

**UPuO2** : keyword to indicate that the **(U,Pu)O<sub>2</sub>** fuel characteristics are going to be defined.  
**NEWFUEL** : keyword defining a new **(U,Pu)O<sub>2</sub>** pellet

**WZUO wzuo** : keyword followed by a real number  $\geq 0$ . defining the (normalized) **non residual** axial power factor.  
**N.B.** : If the **NEUTRO** option is used, this power value is not used. The power taken for the computation is the one entered after the keywords COEFPNEU and COEFPRES in the FUELCHAR operator.

**(WZUORESI wzuoresi)** : keyword followed by a real number  $\geq 0$ . defining the (normalized) **residual** axial power factor. This keyword is optional, and if it is not defined, the default value of WZUORESI is WZUO.

**LAW law** : keyword followed by a 'RADIUS 'POWER' law-type object defining a radial depending profile, i.e., a law expressing the variation in power (real number  $\geq 0$ .) (non dimensional) **as a function of radius** (real number  $\geq 0$ .) (m).

## **Gap characteristics**

**GAP gap** : real number  $> 0$ . defining the initial gap (m) for thermomechanic calculation.  
**N.B** : This value must be in coherency with the minimal value of gap given in the FUELCHAR operator (DELTFUEL).

## **Oxide characteristics**

**OXIDE** : OPTIONAL keyword indicating that the oxide characteristics are going to be defined.  
**EOI eoi** This is followed by the following values :  
**EOE eoe**  

- internal oxide thickness
- external oxide thickness

Default value for these characteristics is  $10^{-7}$  m.  
**: real number  $\geq 0$ .** defining the internal oxide thickness (m).  
**: real number  $\geq 0$ .** defining the external oxide thickness (m).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 188/851

## Cladding characteristics

**CLADDING** : keyword to indicate that the cladding characteristics are going to be defined.

There are seven possibilities for defining the nature of the cladding.

**ZRPHEBUS** : keyword defining PHEBUS type cladding (stress relieved Zircaloy).  
 or  
**ZRCEA** : keyword defining a CEA type cladding (recrystallised Zircaloy).  
 or  
**ZRFRA** : keyword defining a Framatome-ANP Zircalloy-4 type 1 cladding.  
 or  
**ZRFRA2** : keyword defining a Framatome-ANP Zircalloy-4 type 2 cladding.  
 or  
**ZRM5** : keyword defining a Framatome-ANP alloy-M5<sup>TM</sup> type cladding.  
 or  
**ZR4** : keyword defining a Framatome-ANP Zircalloy-4 AFA-2G type cladding.  
 or  
**ZR4H600** : keyword defining a Framatome-ANP Zircalloy-4 AFA-2G hydrided to 600 ppm type  
 cladding.  
 or

material1	: name of either a predefined <b>CATHARE</b> material or a new user one
<b>ALR</b>	: keyword to indicate that the cladding radial thermal expansion coefficient will be given as a polynomial of the cladding temperature (Tc in °C) : $\alpha_r = alr_1 + alr_2 \cdot T_C + alr_3 \cdot T_C^2 + \dots + alr_{nalr} \cdot T_C^{nalr-1}$ It is followed by : nalr : the number of coefficients $alr_1 \dots alr_{nalr}$ : the polynomial coefficients
<b>ALZ</b>	: keyword to indicate that the cladding axial thermal expansion coefficient will be given as a polynomial of the cladding temperature (Tc in °C) : $\alpha_z = alz_1 + alz_2 \cdot T_C + alz_3 \cdot T_C^2 + \dots + alz_{nalz} \cdot T_C^{nalz-1}$ It is followed by : nalz : the number of coefficients $alz_z \dots alz_{nalz}$ : the polynomial coefficients
<b>EYR</b>	: keyword to indicate that the cladding Young's modulus will be given as a polynomial of the cladding temperature (Tc in °C) : $Eyr = eyr_1 + eyr_2 \cdot T_C + eyr_3 \cdot T_C^2 + \dots + eyr_{neyr} \cdot T_C^{neyr-1}$ It is followed by : neyr : the number of coefficients $eyr_1 \dots eyr_{neyr}$ : the polynomial coefficients
<b>RM rm</b>	: real number $\geq 0$ . defining the initial mean cladding radius for thermomechanic calculation (m).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 189/851

**Note :** ZRFRA and ZFRA2 characteristics are defined in private libraries.

**ZRM5, ZR4 and ZR4H600** models are available to all users. They have to fill the ZRCOEFPV.f and M5COEFPV.f subroutines which contains the correlation coefficients . ZRCOEFPV.f contains the mechanical model parameters for **ZRM5, ZR4** and **ZR4H600** and M5COEFPV.f contains the physical parameters attached to the material **ZRM5**.

#### COPERNIC characteristics

<b>NSTRU nstr</b>	: OPTIONAL keyword. newline : integer defining the number of the wall of the FU-ELCHAR element involved in the INTEGRATE directive. This keyword is used to indicate that the COPERNIC models are going to be used for this fuel wall. when NSTRU is used the three following parameters are mandatory:
<b>BURNUP brnp</b>	: real number >0 defining the local burnup (MWJ/t).
<b>CONTp pcont</b>	: real number >0 defining the contact pressure between pellet and cladding (Pa).
<b>FPOROS poros</b>	: real number >0 defining the volumic porosity used for the computation of pellet conductivity.

#### Point neutron kinetics characteristics

<b>NEUTRO</b>	: OPTIONAL keyword indicating that the point neutron kinetics model characteristics are going to be defined. This is followed by :
<b>POWNEUT PROFILE</b>	: keyword to define the neutronic axial power profile. This is followed by : : keyword necessarily followed by as many pairs of (ni valpi) values as there are pairs of meshes to define the segment. As many pairs of (nk valpk) values as required can be added to this list.
<b>ni</b>	: 1 <sup>st</sup> vector mesh cell of the segment with respect to the (X or Y or Z) axis.
<b>valpi</b>	: real number defining the value of the neutronic axial power profile at the first mesh cell of the segment, number ni.
<b>NDATA</b>	: OPTIONAL keyword followed by:
<b>valdzj</b>	: real number defining the value of deltaz from the last mesh ni.
<b>valpj</b>	: real number defining the value of the neutronic axial power profile at valdzj.
<b>nk</b>	: last vector mesh cell of the segment with respect to the (X or Y or Z) axis.
<b>valpk</b>	: real number defining the value of the neutronic axial power profile at the last mesh cell of the segment, number nk.
<b>POWRES PROFILE</b>	: keyword to define the residual axial power profile. This is followed by : : keyword necessarily followed by as many pairs of (ni valpi) values as there are pairs of meshes used to define the segment. As many pairs of (nk valpk) values as required can be added to this list.
<b>ni</b>	: 1 <sup>st</sup> vector mesh cell of the segment with respect to the (X or Y or Z) axis.
<b>valpi</b>	: real number defining the value of the residual axial power profile at the first mesh cell of the segment, number ni.
<b>NDATA</b>	: OPTIONAL keyword followed by:
<b>valdzj</b>	: real number defining the value of deltaz from the last mesh ni.
<b>valpj</b>	: real number defining the value of the residual axial power profile at valdzj.
<b>nk</b>	: last vector mesh cell of the segment with respect to the (X or Y or Z) axis.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 190/851

**valpk** : real number defining the value of the residual axial power profile at the last mesh cell of the segment, number nk.

**MODERAT** : keyword to define the characteristics of the axial anti-reactivity profile, due to moderator density variations.

**PROFILE** : keyword necessarily followed by as many pairs of (ni valpi) values as there are pairs of meshes used to define the segment. As many pairs of (nk valpk) values as required can be added to this list.

**ni** : 1<sup>st</sup> vector mesh cell of the segment with respect to the (X or Y or Z) axis.

**valpi** : real number defining the value of the axial anti-reactivity profile at the first mesh cell of the segment, number ni.

**NDATA** : OPTIONAL keyword followed by:

**valdzj** : real number defining the value of deltz from the last mesh ni.

**valpj** : real number defining the value of the axial anti-reactivity profile at valdzj.

**nk** : last vector mesh cell of the segment with respect to the (X or Y or Z) axis.

**valpk** : real number defining the value of the axial anti-reactivity profile at the last mesh cell of the segment, number nk.

**N.B.** : The moderator anti-reactivity term is expressed in the following form :

$ro = coefm * valmn * [r(t=t) - r(t=0)]$

where r is the density

and coefm is defined in the FUELCHAR operator

**DOPPLER** : keyword to define the characteristics of the axial anti-reactivity profile due to the Doppler effect.

**PROFILE** : keyword necessarily followed by as many pairs of (ni valpi) values as there are pairs of meshes used to define the segment. As many pairs of (nk valpk) values as required can be added to this list.

**ni** : 1<sup>st</sup> vector mesh cell of the segment with respect to the (X or Y or Z) axis.

**valpi** : real number defining the value of the axial anti-reactivity profile at the first mesh cell of the segment, number ni.

**NDATA** : OPTIONAL keyword followed by:

**valdzj** : real number defining the value of deltz from the last mesh ni.

**valpj** : real number defining the value of the axial anti-reactivity profile at valdzj.

**nk** : last vector mesh cell of the segment with respect to the (X or Y or Z) axis.

**valpk** : real number defining the value of the axial anti-reactivity profile at the last mesh cell of the segment, number nk.

**N.B.** : The Doppler anti-reactivity term is expressed in the following form :

$[ro = coefd \cdot valdn \cdot \langle \sqrt{T_f t} - \sqrt{T_f(t=0)} \rangle]$

Where Tf is the mean temperature of fuel (Kelwin) and coefd is defined in the FUELCHAR operator.

### Example

1)law1=	LAW	RADIUS'	'POWER'
		0.D0	0.93504
		1.832D-3	0.95497
		2.591D-3	0.98539

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 191/851

		3.173D-3	1.01308		
		3.664D-3	1.04059		
		4.096D-3	1.06135;		
fuel1=	FUEL3D	hotcore	INTERNAL		
	SEGMENT	1	10		
	ISO	6	DIAM	0.0D0	8.192D-3
	UO <sub>2</sub>	IRRAFUEL			
			WZUO	0.31578	
			LAW	law1	
	GAP	91.0D-6			
	CLADDING	ZRCEA			
		RM	4.4469D-3		;
fuel2=	FUEL3D	hotcore	INTERNAL		
	SEGMENT	1	10		
	ISO	6	DIAM	0.0D0	8.192D-3
	UO2	NEWFUEL			
		WZUO	0.31578		
		LAW	law1		
	GAP	91.0D-6			
	CLADDING	ZRPHEBUS			
		RM	4.4469D-3		
		NEUTRO			
		POWNEUT	PROFILE	1	0.876
				NDATA	0.445
					0.785
			...		
			10		0.876
	POWRES	PROFILE	1		0.876
			NDATA	0.445	0.5
					0.785
			...		
			10		0.876
	MODERAT	PROFILE	1		0.876
			NDATA	0.445	0.5
					0.785
			...		
	DOPPLER	PROFILE	1		0.889
			NDATA	0.445	0.5
					0.785
			...		
			10		0.669
					;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 192/851

60

## FUELCHAR GROUP OPERATOR

The **FUELCHAR GROUP** operator creates a FUELCHAR object of type **GROUP** in the *data block*. This operator must be coupled to an **AXIAL GROUP** element. It links for each axial element of the group a fuelchar element copied from a model already defined in the data block.

### Associated Keywords

JUNCTION GROUP, AXIAL GROUP, WALL GROUP, FUELCHAR GROUP, BCONDIT GROUP, ZONE, CIRCUIT, PERMITIN, REALC

### Syntax

```
funal =      FUELCHAR  GROUP      axna      TEMPLATE  funa2 ;
```

<b>funal</b>	: Name of a <b>FUELCHAR GROUP</b> element. It must not exceed 5 characters.
<b>axna</b>	: Name of an <b>AXIAL GROUP</b> element
<b>TEMPLATE funa2</b>	: Keyword followed by the name of a fuelchar object defined in the data block. This operator will duplicate the characteristics of the funa2 fuelchar for each axial element contained in the <b>AXIAL GROUP</b> element.

### Example

The axial coeurmoy and its fuelchar carcb are defined first.

```
carcb =      FUELCHAR  coeurmoy
              GAP        DELTFUEL   1.0D-6
              GAPP       94.8D5
              CRAD       3.145     FUELP
              INTERNAL  POWNEUT   68.290D3
              POWRESI   0.0        LAWNEUT   loipui
              LAWRESI   loipui    GASVOL    VOIDV    2.575D-6
              EXPANV    5.288D-6   BPLUGV    0.450D-6
              CRACKV    0.316D-6   POROSV    0.D0
              TPLUGV    0.450D-6   VOLFRAC   0.98593D0
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 193/851

**POROS**      5.94D-2      **XNEUT**      0.974D0  
; ;

bota=      **JUNCTION**      **GROUP**      157      **SUFFIX**      1  
**WEIGHT**      **CONST**      264      ; ;

topa=      **JUNCTION**      **GROUP**      157      **SUFFIX**      1  
**WEIGHT**      **CONST**      264      ; ;

cana =      **AXIAL**      **GROUP**      **TEMPLATE**  
coeurmoy      bota      **USTREAM**  
topa      **DSTREAM**      ; ;

Then the **FUELCHAR GROUP** wcana can be defined: wcana will contain 157 identical fuelchar called wcana001 to wcana157. These fuelchar elements will be linked to the axial elements cana001 to cana157.

wcana =      **FUELCHAR**      **GROUP**  
cana      **TEMPLATE**      carc b ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 194/851

61

## FUELCHAR OPERATOR

The **FUELCHAR** operator defines the characteristics of a **fuel-structure** for fuel rods **with UO<sub>2</sub> pellets**. A fuel-structure groups together a number of **fuel walls** of the same element. For example, a fuel rod bundle can be described by a fuel-structure. When the fuel wall is integrated (see **INTEGRATE**) the object created in this way will be included in the computation. The **FUELCHAR** directive is used in the data block.

**N.B. :** The **NEUTRO** option of the **FUELCHAR** operator must be used in conjunction with the **NEUTRO** option of the **FUEL** (or **FUEL3D**) operator and must come before the **CORE** operator.

### Associated Keywords

AND, FUEL, FUEL3D, GOFUEL, INTEGRATE, POWER, RSETFUEL, STOPFUEL, XNEULIST, XNEULISX, PNRSHAPE, PNRSHAPX, PRESHAPE, PRESHAPX, FUEL, HTCBACON, HTCBYHL, STOPACON, STOPYHL, CLOSEGAP, FUELDTMX, GOBALLON, XRESLIST, XRESLISX, MODXRES, REFLCHAR, REFLCH3D, REFLOOD, MODXNEUT, MODXRES, OXRATE, PICTG, VALUE FOR FUEL, WRITE FOR 3D FUEL

### Syntax

<b>char1 =</b>	<b>FUELCHAR</b>	elem1	
	<b>(NCHANNEL</b>	nchannel1)	
	<b>(WREFLINK</b>	fuelref )	or <b>(WREFLINK NOREFLAW)</b>
	<b>(RADIATW)</b>		
	<b>GAP</b>		
		<b>DELTIFUEL</b>	deltfuel
		<b>GAPP</b>	gapp
	<b>CRAD</b>	crad	
	<b>FUELFP</b>	<b>NEUTRO</b>	
		<b>COEFPNEU</b>	coefpneu
		<b>COEPFPRES</b>	coepfpres
		<b>COEFM</b>	coefm
		<b>COEFD</b>	coefd
		or	
		<b>EXTERNAL</b>	
			<b>POWNEUT</b> powneut
			<b>POWRES</b> powres
		or	
		<b>INTERNAL</b>	
			<b>POWNEUT</b> powneut

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 195/851

	<b>POWRESI</b> powres <b>LAWNEUT</b> lawneut <b>LAWRESI</b> lawresi <b>(LININTER)</b>	
or		
	<b>CATAFUEL</b>	
	<b>COEFPNEU</b> coefpneu <b>POWRESI</b> powres <b>LAWRESI</b> lawresi	
<b>GASVOL</b>  <b>VOLFRAC</b> <b>POROS</b>	<b>VOIDV</b> voidv <b>EXPANV</b> expanv <b>BPLUGV</b> bplugv <b>CRACKV</b> crackv <b>POROSV</b> porosv <b>TPLUGV</b> tplugv  volfrac poros	
<b>(EXCENTRI</b>  <b>XNEUT</b> <b>(XRES</b>	excentri )  xneut xres )	
<b>(RUPTFRAG</b> <b>(RUPTFLD</b> <b>(RAYCOLD</b>	nmesh ) STEAM raycold)	or <b>HELIUM</b> )
<b>(COPERNIC</b>	<b>NSTRU</b> nstr <b>FILE</b> 'FILENAME' <b>GAZMIX</b> ahe      aar      akr axe      an2      ao2      aco2 <b>ENRICH</b> xuo2 <b>MOXIND</b> xmox <b>ENRGAD</b> xgad <b>ROUGHG</b> crough <b>ROUGHF</b> frough <b>CLADD</b> dcclad )	
<b>(TYPEOX</b>	typeox )	;

**char1** : fuelchar object  
**elem1** : axial, hydimp or threed element  
**NCHANNEL** : OPTIONAL keyword, followed by an integer  $\geq 0$ , defining the number of identical fuel rods in the fuel-structure.  
**nchannel**  
**The default setting** is a single fuel rod and channel = 1. To represent a **theoretical** rod, i.e. a rod not acting on hydraulic conditions, nchannel must be 0.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 196/851

<b>WREFLINK</b>	<p>: OPTIONAL keyword defining the reference reflooded fuelchar object. This keyword allows the fuelchar char1 to use the same physical correlations (specific in case of reflooding, i.e. to calculate the wall-fluid heat exchanges) as the fuelchar (or wall) fuelref. Three cases are possible depending on the relative position between char1 and fuelref:</p> <ul style="list-style-type: none"> <li>- partial overlapping: WREFLINK fuelref (MANDATORY)</li> <li>- complete overlapping: WREFLINK fuelref (by default)</li> <li>- no overlapping NOREFLAW (by default)</li> </ul>
<b>fuelref</b>	<p>: name of the reference reflooded fuelchar (or wall). Its reflooding characteristics must have already been defined (see REFLCHAR or REFLCH3D). But none reflooding characteristics must be defined for fuelchar char1.</p>
<b>NOREFLAW</b>	<p>: keyword indicating that the fuelchar char1 uses the standard physical laws (i.e. without reflooding).</p>
<b>RADIATW</b>	<p>: OPTIONAL keyword indicating that the radiation heat transfer over 5 bars will be limited to its value for 5 bars.</p>
<b>GAP</b> <b>DELTIFUEL</b> <b>deltfuel</b> <b>GAPP gapp</b>	<p>: keyword to indicate that the characteristics of the gap are going to be defined.          : keyword followed by a real number &gt; 0. which defines the minimum value of the gap width (m).          : keyword followed by a real number &gt; 0. which defines the initial pressure in the gap for thermomechanic calculation (Pa).</p>
<b>CRAD crad</b>	<p>: keyword followed by a real number &gt; 0. which defines the radius to reach contact between two pellets (m).</p>
<b>FUELP</b>	<p>: keyword to indicate that the power characteristics for the whole group of rods in the fuel-structure are going to be defined. It is followed by:</p>
<b>NEUTRO</b>	<p>: keyword used when a neutron calculation is requested (a CORE element should exist in the circuit), and indicating that the point neutron kinetics model characteristics are going to be defined. One part of this model is defined in the FUEL (or FUEL3D) operator. It is followed by:</p>
<b>COEFPNEU</b> <b>coefpneu</b>	<p>: keyword followed by a real number &gt; 0. defining the neutronic power coefficient on the rod.  <u>N.B.</u> : the segment is defined in the FUEL operator, with keyword PROFILE. This remark is also valid for the three following coefficients COEFPRES, COEFM, COEFD.</p>
<b>COEFPRES</b> <b>coefpres</b> <b>COEFM</b> <b>coefm</b>	<p>: keyword followed by a real number &gt; 0. defining the residual power coefficient on the rod.</p>
<b>COEFD</b> <b>coefd</b> Or <b>EXTERNAL</b>	<p>: keyword followed by a real number &gt; 0. defining the anti-reactivity coefficient resulting from moderator density variations for the rod (in dollar – that is pcm/BETA).          : keyword followed by a real number &gt; 0 defining the anti-reactivity coefficient resulting from the Doppler effect for the rod (in dollar).</p>
<b>POWNEUT</b> <b>powneut</b>	<p>: keyword indicating that the time-function laws for the neutronic and residual power are defined externally. It is followed by:</p>
<b>POWRES</b> <b>powres</b>	<p>: keyword followed by a real number &gt; 0. which defines the non residual (or neutronic) power generated by the whole fuel rod (W).  <u>N.B.</u> : if a CORE element exists in the same circuit, this power value is not used in the computation ; the core power is used instead.          : keyword followed by a real number &gt; 0. which defines the residual power generated by the whole fuel rod (W).  <u>N.B.</u> : if a CORE element exists in the same circuit, this power value is not used in the computation ; the core power is used instead.</p>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 197/851

Or

**INTERNAL**

: keyword indicating that the time-function laws for the neutronic and residual power are defined internally. It is followed by:

**POWNEUT**  
**powneut**

: keyword followed by a real number  $> 0$ . which defines the non residual (or neutronic) power generated by the whole fuel rod (W).

**N.B.** : if a CORE element exists in the same circuit, this power value is not used in the computation ; the core power is used instead.

**POWRESI** **powres**

: keyword followed by a real number  $> 0$ . which defines the residual power generated by the whole fuel rod (W).

**N.B.** : if a CORE element exists in the same circuit, this power value is not used in the computation ; the core power is used instead.

**LAWNEUT** **lawneut**

: keyword followed by a law which defines the variation in non residual power (real number  $> 0$ ) as a function of time (s) (used as a multiplicative coefficient of powneut).

**N.B.** : if a CORE element exists in the same circuit, this law is not taken into consideration but is recalculated by the code as a function of neutron data. (Using the value given after the COEFPNEU (see NEUTRO above) and the initial neutron power given after the PO keyword of the CORE operator).

**LAWRESI** **lawresi**

: keyword followed by a law which defines the variation in residual power (real number  $> 0$ ) as a function of time (s) (used as a multiplicative coefficient of Powers).

**N.B.** : if a CORE element exists in the same circuit, this law is not taken into consideration but is recalculated by the code as a function of neutron data. (Using the value given after the COEFPRES (see NEUTRO above) and the initial neutron power given after the PO keyword of the CORE operator).

**LININTER**

: OPTIONAL keyword used to indicate that the linear interpolation will be used instead of the logarithmic interpolation (default law) for the calculation of the residual and non residual power.

Or

**CATAFUEL**

: keyword to indicate that the calculation is a fuel standalone computation using, for the fuel-structure, the power stored in a **CATHARE** hydraulic file:

: keyword followed by a real number  $> 0$ . defining the multiplicative coefficient to apply to the non residual power stored in the **CATHARE** hydraulic file.

: keyword followed by a real number  $> 0$ . which defines the residual power generated by the whole fuel rod (W).

: keyword followed by a law which defines the variation in relative residual power (real number  $> 0$ ) as a function of time (s) (multiplicative coefficient of ?owers value).

**GASVOL**

: keyword to define the various volumes of gas trapped in the fuel. It is followed by:

**VOIDV** **voidv**

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the voids at high temperature ( $m^3$ ).

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the upper expansion volume at high temperature ( $m^3$ ).

**EXPANV** **expansv**

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the volume of the bottom plug at high temperature ( $m^3$ ).

**BPLUGV** **bplugv**

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the cracks at high temperature ( $m^3$ ).

**CRACKV** **crackv**

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the porosity at high temperature ( $m^3$ ).

**POROSV** **porosv**

: keyword followed by a real number  $> 0$ . which defines the volume of gas trapped in the volume of the top plug at high temperature ( $m^3$ ).

**TPLUGV** **tplugv**

: keyword followed by a real number  $> 0$ . and  $< 1$ . which defines the volume fraction of **UO<sub>2</sub>** (to take into account the voids in the pellet) (dimensionless).

**VOLFRAC**

**volfrac**

: keyword followed by a real number  $> 0$ . and  $< 1$ . which defines the volume fraction of **UO<sub>2</sub>** (to take into account the voids in the pellet) (dimensionless).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 198/851</a>

<b>POROS poros</b>	: keyword followed by a real number > 0. and < 1. which defines the porosity of the $\text{UO}_2$ (dimensionless).
<b>EXCENTRI excen-tri</b>	: OPTIONAL keyword followed by a real number > 0 which defines the eccentricity of the $\text{UO}_2$ pellets which is used by the hot spot model (dimensionless). When the fuel pellets and the cladding are concentric,excentri = 0. The eccentricity becomes higher than 1 when there is contact between the pellets and the cladding.
<b>XNEUT xneut</b>	: keyword followed by a real number > 0. and < 1. which defines the fraction of neutron power released in the fuel.
<b>XRES xres</b>	: OPTIONAL keyword followed by a real number > 0. and < 1. which defines the fraction of residual power released in the fuel, (the fraction 1-xres will be released in the coolant). Default value is 1.
<b>RUPTFRAG nmesh</b>	: OPTIONAL keyword followed by an integer >0 which defines the mesh number where the rupture will occur when the condition of fragile rupture is fulfilled, that is to say when the pressure inside the gap between the pellet and the cladding becomes greater than the outside pressure.
<b>RUPTFLD STEAM or HELIUM</b>	: OPTIONAL keyword followed by the name of the fluid which fills the gap where the rupture of the cladding occurs. Default value is STEAM
<b>RAYCOLD raycold</b>	: OPTIONAL keyword followed by a real number > 0 which defines the cold radius of the $\text{UO}_2$ pellets which is used to calculate $\text{UO}_2$ density (m). Default value is 0.D0 If used, $\text{UO}_2$ density is calculated in each axial mesh as follow: $\rho = \rho_{ini} * (\text{RAYCOLD}^2 / \text{RAY}^2)$ with RAY= current radius of the pellet and $\rho_{ini} = 10950 \text{ kg/m}^3$
<b>COPERNIC</b>	: OPTIONAL keyword used to indicate that the fuel COPERNIC models are going to be used. <b>When the keyword COPERNIC is used, following keywords are mandatory.</b>
<b>NSTRU nstr</b>	: keyword followed by an integer >0 which defines the wall number involved in the INTEGRATE directive. This number must be the same for all the FUEL3D or FUEL linked to this FUELCHAR element.
<b>FILE filename</b>	: keyword followed by a file name containing the local burnups, local porosities, and local factors of flux depression. <b>Warning:</b> Be careful that the tabulation character is forbidden in this file.
<b>GAZMIX ahe aar akr axe an2 ao2 aco2</b>	: keyword followed by seven real numbers defining the gases composition in the gap between cladding and pellet. The seven gases are read in the following order : He, Ar, Kr, Xe, N2, O2, CO2
<b>ENRICH xu02</b>	: keyword followed by a real number defining the fuel enrichment in $\text{UO}_2$ .
<b>MOXIND xmox</b>	: keyword followed by a real number the fuel enrichment in MOX.
<b>ENRGAD xgad</b>	: keyword followed by a real number defining the Gadolinium enrichment.
<b>ROUGHG crough</b>	: keyword followed by a real number defining the roughness of the cladding surface (m).
<b>ROUGHF frough</b>	: keyword followed by a real number defining the roughness of the pellet surface (m).
<b>CLADDG dclad</b>	: keyword followed by a real number defining the hot cladding thickness (m).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 199/851

**TYPEOX typeox** : OPTIONAL keyword followed by a keyword that represents the oxidation law to be used for the fuel rod. This keyword can be STANDARD (same as default value), to use the default Cathcart-Pawell's law, or BAKERJUS to use the Baker-Just oxidation law. It can be as well CATHCART, and then the law used is the Cathcart-Pawell law describing the total oxygen consumption.

### Example

```

1)
law1=      LAW          'TIME'        'POWER'
           0.            1.
           0.2           0.5
           0.5           0.1
           0.2           0.03
           100.          0.03;
               03;

law2=      LAW          'TIME'        'POWER'
           0             0.052
           0.5           00.05167
           0.15          0.04839
           0.4            0.04501;

meancore=   AXIAL        meanlow      USTREAM
           meanupp      DSTREAM
           WEIGHT       41448;

charac1=    FUELCHAR    meancore
           GAP          DELTFUEL   1.D-6
                           GAPP       94.8D5
           CRAD          3.145D-3
           FUELP
           INTERNAL     POWNEUT    97997
                           LAWNEUT    law1
           GASVOL        VOIDV      2.575D-6
                           EXPANV     5.288D-6
                           BPLUGV     0.225D-6
                           CRACKV     0.316D-6
                           POROSV     0.0
                           TPLUGV     0.225D-6
           VOLFRAC      0.98593
           POROS         5.94D-2
           EXCENTRI     1.D0
           XNEUT         0.976;
               07;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 200/851

2)

meancore= AXIAL meanlow USTREAM  
 meanupp DSTREAM;  
  
 charac2= FUELCHAR meancore  
 NCHANNEL 41184  
 GAP  
 CRAD DELTFUEL 1.E-6  
 FUELP GAPP 94.8E5  
 NEUTRO 3.145E-3  
  
 COEFPNEU 1.0  
 COEFPRES 0.62  
 COEFM 6.62D-2  
 COEFD 0.3015D0  
  
 GASVOL VOIDV 2.575E-6  
 EXPANV 5.288E-6  
 BPLUGV 0.225E-6  
 CRACKV 0.316E-6  
 POROSV 0.0  
 TPLUGV 0.225E-6  
  
 VOLFRAC 0.98593  
 POROS 5.94E-2  
 EXCENTRI 1.E0  
 XNEUT 0.974 ;  
  
 ;

corecho= AXIAL lowcho USTREAM  
 uppcho DSTREAM  
  
 charac3= FUELCHAR corecho  
 NCHANNEL 264  
 GAP  
 CRAD DELTFUEL 1.E-6  
 FUELP GAPP 94.8E5  
 NEUTRO 3.145E-3  
  
 COEFPNEU 1.0  
 COEFPRES 0.62  
 COEFM 6.62D-2  
 COEFD 0.3015D0  
  
 GASVOL VOIDV 2.575E-6  
 EXPANV 5.288E-6  
 BPLUGV 0.225E-6  
 CRACKV 0.316E-6  
 POROSV 0.0  
 TPLUGV 0.225E-6  
  
 VOLFRAC 0.98593

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 201/851

POROS	5.94E-2
EXCENTRI	1.E0
XNEUT	0.976
XRES	0.980
	;

3) Theoretical rod (without neutronics)

charac4=	FUELCHAR	corecho		
	NCHANNEL	0		
	GAP			
		DELTfuel	1.E-6	
		GAPP	94.8E5	
	CRAD	3.145E-3		
	FUELp			
	EXTERNAL	POWNEUT	103.8E3	
	GASVOL		POWRES	34500
		VOIDV	2.575E-6	
		EXPANV	5.288E-6	
		BPLUGV	0.225E-6	
		CRACKV	0.316E-6	
		POROSV	0.0	
		TPLUGV	0.225E-6	
	VOLFRAC	0.98593E0		
	POROS	5.94E-2		
	EXCENTRI	1.E0		
	XNEUT	1.	;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 202/851

62

## FUELDTMX DIRECTIVE

The **FUELDTMX** directive, used in the *command block*, allows imposing an appropriate step time value when approaching cladding rupture and immediately after. The new time step management depends on the following four criteria, tested for each rod object:

1. The time step  $dt_1$  is applied when the clad temperature is over a specific value “**Tclad1**”,
2. Before the clad rupture:
  - (a) The time step  $dt_2$  is applied on a strain condition when the fraction  $\frac{\varepsilon}{\varepsilon_r}$  is greater than the specific value “**epscri2**” or on a stress condition when  $\frac{\sigma}{\sigma_r}$  is greater than the specific value “**sigeri2**”,
  - (b) The time step  $dt_3$  is applied on a strain condition when  $(\varepsilon_r - \varepsilon)$  is less than the specific value “**epscri3**” or on a stress condition when  $\frac{\sigma}{\sigma_r}$  is greater than the specific value “**sigeri3**”. In these two cases the clad temperature must be over the specific value “**Tclad3**”,
3. After the clad rupture:
  - (a) the time step  $dt_4$  is applied as long as the internal oxide layer thickness is less than a specific value “**eoxcri4**”,
  - (b) The fuel time step management is stopped when the current time is larger than the rupture time increase specified by the user “**delta\_t**”.

**Remark :** This last condition can be ignored if the user specifies a large value for “**delta\_t**”. In such a case, the last time step criterion ( $dt_1$ ,  $dt_2$ ,  $dt_3$  or  $dt_4$ ) is kept as long as cladding temperature remains above value “**Tclad1**”.

All the data parameters values are encoded in the READER (default values), but if the user needs to modify one or several parameters, he must describe all the parameters values in the directive.

Time step management is not taken into account if maximum cladding temperature drops below “**Tclad1**” due to a temporary cooling phase; however time step management is again effective when maximum cladding temperature increases again above “**Tclad1**”.

On the contrary, time step management is deactivated after clad burst when the first of the two following conditions is met: internal oxide thickness greater than “**eoxcri4**” or “time elapsed from burst” is greater than “**delta\_t**”.

An additional test is introduced to stop calculation if clad rupture has occurred without application of time step reduction ( $dt_1$ ,  $dt_2$ ,  $dt_3$  or  $dt_4$ ).

### Associated Keywords

GOFUEL, FUELCHAR, FUEL, FUEL3D

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 203/851

### Syntax

```
FUELDTMX elem delta_t
( Tclad1      Tclad3
  epscri2     epscri3
  sigcri2     sigcri3
  eoxcri4
  dt1          dt2          dt3          dt4
) ;
```

<b>elem</b>	: Name of the hydraulic element which contains the 1D or 3D fuel wall element(s).
<b>delta_t</b>	: Time interval after the rupture, for which the last value of fuel time step is kept. This condition can be ignored if the user specifies a large value.
<b>Tclad1</b>	: Maximum value of the clad temperature for the first criterion (K). The default value is 650°C.
<b>Tclad3</b>	: Maximum value of the clad temperature for the third criterion (K). The default value is 600°C.
<b>epscri2</b>	: Strain condition for the second criterion. The default value is 0.40.
<b>epscri3</b>	: Strain condition for the third criterion (m). The default value is 0.03.
<b>sigcri2</b>	: Stress condition for the second criterion. The default value is 0.40.
<b>sigcri3</b>	: Stress condition for the third criterion. The default value is 0.98.
<b>eoxcri4</b>	: Minimal internal oxide layer thickness for the fourth criterion (m). The default value is $10^{-6}$ m.
<b>dt1</b>	New time step associated to the parameter Tclad1 (s). The default value is 0.1s.
<b>dt2</b>	New time step associated to the parameters epscri2 and sigcri2 (s). The default value is 0.05s.
<b>dt3</b>	New time step associated to the parameters epscri3, sigcri3 and Tclad3 (s). The default value is 0.01s.
<b>dt4</b>	New time step associated to the parameter eoxcri4 (s). The default value is 0.003s.

**Remarks:**

1. This directive must be called after the GOFUEL directive.
2. For each criterion, the step time value will be used only if it is the minimal value of the step time control values.

### Example

1. In case the user uses the default values of the criteria parameters (default values specified beforehand):  

```
FUELDTMX COEURMOY 10. ;
```
2. In case the user modifies the time values of the criteria and does not use a condition on "delta\_t" to stop the fuel time step management after the clad rupture:  

```
FUELDTMX COEURMOY 10D10 650.0D0 850.0DO 0.40D0 0.03D0 0.40D0 0.98D0
1.0D-6 5.0D-1 1.0D-2 1.0D-3 1.0D-4 ;
```

**NB :** The corresponding FORTRAN call is : CALL FUELDTMX (OBJNAM,00F(1), \*9999).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 204/851

**OBJNAM** CHARACTER\*8 hydraulic element name.  
**00F** Array of DOUBLE PRECISION containing the different values of the criteria parameters:  
(delta\_t, Tclad1, Tclad2, epscri2, epscri3, sigcri2, sigcri3, eoxcri4, dt1, dt2, dt3 and  
dt4).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 205/851

63

## FUEL OPERATOR

The **FUEL** operator is used in the *data block* to define fuel rods with **UO<sub>2</sub>** or **(U,Pu)O<sub>2</sub>** pellets on an axial or an hydimp element. The **FUEL** operator creates a fuel object, defining its characteristics. The object thus defined will be included in the computation only after it has been integrated (see **INTEGRATE**).

**N.B. :**

1. Fuel walls cannot be defined on volume, bcondit elements or gadgets. It can be defined on a threed element with **FUEL3D** operator.
2. If the **NEUTRO** option of the **FUEL** operator is used, then the **NEUTRO** option of the **FUELCHAR** operator must be used too. If the **NEUTRO** option of the **FUEL** operator is used, it has to come before the **CORE** operator, which also has to be used.
3. Oxidation phenomena is only taken into account for Zircaloy predefined cladding materials.

For an axial or an hydimp element, the fuel object is defined on segments delimited by 2 vector **points which must belong to the element**. A mesh **cannot be repeated** within a fuel object. The fuel object contains **all the** segments to be **INTEGRATED** together.

<b>Associated Keywords</b>
----------------------------

**AND, FUELCHAR, FUEL3D, GOFUEL, INTEGRATE, POWER, VALUE FOR FUEL, WRITE FOR FUEL**

<b>Syntax</b>
---------------

```

comb1=   FUEL           elem1      INTERNAL
          SEGMENT        ipi         ipj
          (...)          ipk         ipk)
          DATA           nm1         nm1
                           DIAM       d1         d2
                           ...         ...       dnm1+1
          or
          ISO            nm1         dio        duo2
                           DIAM

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 206/851

<b>UO2</b>	<b>NEWFUEL</b> or <b>IRRAFUEL</b> or <b>SCARFUEL</b> <b>CP1</b> or <b>CP2</b> or <b>P4</b> or <b>PP4</b> or <b>N4</b> or <b>USER</b>
<b>UPUO2</b>	<b>NEWFUEL</b>
<b>GAP</b> <b>(OXIDE)</b>	<b>WZUO</b> wzuo <b>(WZUORESI</b> wzuoresi) <b>LAW</b> law <b>gap</b>
<b>CLADDING</b>	<b>EOI</b> eoи <b>EOE</b> eoе)
<b>( NSTRU</b>	<b>ZRPHEBUS</b> or <b>ZRCEA</b> or <b>ZRFRA</b> or <b>material1</b> <b>RM</b> nstr <b>BURNUP</b> <b>CONTП</b> <b>FPOROS</b>
<b>)</b>	<b>ALR</b> nalr alr <sub>1</sub> ... alr <sub>nalr</sub> <b>ALZ</b> nalz alz <sub>1</sub> ... alz <sub>nalz</sub> <b>EYR</b> neyr eyr <sub>1</sub> ... eyr <sub>neyr</sub> <b>rm</b>
<b>(NEUTRO</b>	<b>PROFILE</b> Ipi               valpni Ipj               valpnj ... (Ipk              valpnk Ipl               valpnл)
<b>POWNEUT</b>	<b>PROFILE</b> Ipi               valpri Ipj               valprj ... (Ipk              valprk Ipl               valprл)
<b>POWRES</b>	<b>PROFILE</b> Ipi               valprk Ipj               valprл)
<b>MODERAT</b>	<b>PROFILE</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 207/851

```

Ipi          valmi
Ipj          valmj
...
(Ipk         valmk
Ipl         valml)
DOPPLER PROFILE
Ipi          valdi
Ipj          valdj
...
(Ipk         valdk
Ipl         valdl)
);

```

**elem1** : axial or hydimp element.

**INTERNAL SEGMENT** : keyword to indicate that the fuel wall is necessarily within the flow.  
: keyword to indicate that at least one segment on which a fuel wall is to be defined, is going to be read. It is followed by as many pairs of points as required.

**ipi ipj** : Pair of vector points which define the beginning and end of the segment. They must belong to the axial mesh of the element.

#### Radial meshing of UO<sub>2</sub> pellet (see CATHARE2 user manual for more explanations):

The diameters will be given in increasing order (m). The diameters are constant along the segment.

The radial mesh of the fuel can be entered in one of the two following ways :

**DATA nm1** : keyword to indicate that the radial meshing is to be defined **mesh by mesh**. This is followed by an integer > 0 defining the number of elementary radial meshes.

**DIAM d1 d2 ...dnm1+1** : keyword to indicate that the diameters are constant along the segment. This is followed by nm1+1 real numbers > 0., defining the diameter of each radial mesh.

**N.B** :The first diameter d1 corresponds to the inside diameter of the UO<sub>2</sub> (in order to be able to define the diameter of the hole in the middle of the fuel rod), the last diameter dnm1+1corresponds to the outside diameter of UO<sub>2</sub> ; both are initial values for thermomechanic calculation.

Or

**ISO nm1** : keyword to indicate that the radial meshing is **automatically isovolume**. It is followed by an integer > 0 defining the number of elementary meshes in the wall thickness.

**DIAM dio duo2** : keyword to indicate that the diameters are constant along the segment. It is followed by 2 real numbers > 0. defining the inside and outside diameters of the wall.

**N.B** :The first diameter dio corresponds to the inside diameter of UO<sub>2</sub> (to be able to define the diameter of the hole in the middle of the fuel rod), the last diameter duo2 corresponds to the outside diameter of UO<sub>2</sub> ; both are initial values for thermomechanic calculation.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 208/851

### **UO<sub>2</sub>/(U,Pu)O<sub>2</sub> Characteristics:**

**UO2** : keyword to indicate that the UO<sub>2</sub> fuel characteristics are going to be defined.

There are three possible ways of defining the UO<sub>2</sub> fuel pellet characteristics:

**NEWFUEL** : keyword defining a new UO<sub>2</sub> pellet.

or

**IRRAFUEL** : keyword defining an irradiated (used) UO<sub>2</sub> pellet.

or

**SCARFUEL** : keyword defining a ‘scarfuel’ UO<sub>2</sub> pellet, whose irradiation rate will depend on the burn up value given by the user (this burn up value BU is given by the directive RSETFUEL) to take into account the local irradiation rate thanks to the RSETFUEL directive. It allows a fuel properties adjustment to fit computations made by other codes (LIBEL-LULE ...). It should be used in the frame of the SCAR projects and studies.

It is followed by:

**CP1** : keyword defining the plant series name, which indicates which library (LIBFUELCP1.f) to use for the adjustment calculation (linked with RSETFUEL directive).

**Or N4, P4,  
PP4, CP2** : keyword defining the plant series name, which indicates which library to use for the adjustment calculation (linked with RSETFUEL directive).

**N.B.:** the data relative to N4, P4, PP4, CP2 plant series are not implemented yet.

**Or USER** : keyword indicating that a user library will be used for the adjustment calculation (linked with RSETFUEL directive).

**N.B.:** the characteristics must fill in a LIBFUELUSR.f library before using this option.

**UPuO2** : keyword to indicate that the (U,Pu)O<sub>2</sub> fuel characteristics are going to be defined.

**NEWFUEL** : keyword defining a new (U,Pu)O<sub>2</sub> pellet.

**WZUO** : keyword followed by a real number  $\geq 0$ . defining the (normalized) **non residual** axial power factor.

**N.B. :** If the NEUTRO option is used, this power value is not used. The power taken for the computation is the one entered after the keywords COEFPNEU and COEFPRES in the FUELCHAR operator.

**(WZUORESI  
wzuoresi)** : keyword followed by a real number  $\geq 0$ . defining the (normalized) **residual** axial power factor. This keyword is OPTIONAL. If it is not defined, the default value of WZUORESI is WZUO.

**LAW law** : keyword followed by a ‘RADIUS’ ‘POWER’ law-type object defining a radial depending profile, i.e., a law expressing the power variation (real number  $\geq 0$ .) (non dimensional) as a **function of radius** (real number  $\geq 0$ .) (m).

### **Gap characteristics:**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 209/851

**GAP gap** : real number  $> 0$ . defining the initial gap (m) for thermo mechanic calculation.  
N.B : This value must be in coherency with the minimal value of gap given in the FUELCHAR operator (DELTfuel).

#### Oxide characteristics:

**OXIDE** : OPTIONAL keyword indicating that the oxide characteristics are going to be defined.  
This is followed by the internal and external oxide thickness  
The default value for these characteristics is  $10^{-7}$  m.

**EOI eoi** : real number  $\geq 0$ . defining the internal oxide thickness (m).  
**EOE eoe** : real number  $\geq 0$ . defining the external oxide thickness (m).

#### Cladding characteristics:

**CLADDING** : keyword to indicate that the cladding characteristics are going to be defined.

There are seven possibilities for defining the nature of the cladding:

**ZRPHEBUS** : keyword defining PHEBUS type cladding (stress relieved Zircaloy).  
or  
**ZRCEA** : keyword defining a CEA type cladding (recrystallised Zircaloy).  
or  
**ZRFRA** : keyword defining a Framatome-ANP Zircalloy-4 type 1 cladding.  
or  
**ZRFRA2** : keyword defining a Framatome-ANP Zircalloy-4 type 2 cladding.  
or  
**ZRM5** : keyword defining a Framatome-ANP alloy-M5<sup>TM</sup> type cladding.  
or  
**ZR4** : keyword defining a Framatome-ANP Zircalloy-4 AFA-2G type cladding.  
or  
**ZR4H600** : keyword defining a Framatome-ANP Zircalloy-4 AFA-2G hydrided to 600 ppm type cladding.  
or

<b>material1</b> <b>ALR</b>  <b>nalr</b> <b>alr<sub>1</sub> ... alr<sub>nalr</sub></b>	: name of either a predefined <b>CATHARE</b> material or a new user one. : keyword to indicate that the cladding radial thermal expansion coefficient will be given as a polynomial of the cladding temperature (Tc in °C): $\alpha_r = alr_1 + alr_2 \cdot T_c + alr_3 \cdot T_c^2 + \dots + alr_{nalr} \cdot T_c^{nalr-1}$ It is followed by : : the number of coefficients. : the polynomial coefficients.
<b>ALZ</b>  <b>nalz</b>	: keyword to indicate that the cladding axial thermal expansion coefficient will be given as a polynomial of the cladding temperature (Tc in °C): $\alpha_z = alz_1 + alz_2 \cdot T_c + alz_3 \cdot T_c^2 + \dots + alz_{nalz} \cdot T_c^{nalz-1}$ It is followed by : : the number of coefficients.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 210/851</a>

<p><b>alrz ... alz<sub>nalz</sub></b></p> <p><b>EYR</b></p> <p><b>neyr</b></p> <p><b>eyr<sub>1</sub> ... eyr<sub>neyr</sub></b></p> <p><b>RM rm</b></p>	<p>: the polynomial coefficients.</p> <p>: keyword to indicate that the cladding Young's modulus will be given as a polynomial of the cladding temperature (Tc in °C):  <math>Ey_r = eyr_1 + eyr_2 \cdot T_c + eyr_3 \cdot T_c^2 + \dots + eyr_{nalr} \cdot T_c^{nalr-1}</math>  It is followed by:</p> <p>: the number of coefficients.</p> <p>: the polynomial coefficients.</p> <p>: real number <math>\geq 0</math>. defining the initial mean cladding radius for thermomechanic calculation (m).</p>
---	--

**Note :** **ZRFRA** and **ZFRA2** characteristics are defined in private libraries.

**ZRM5**, **ZR4** and **ZR4H600** models are available to all users. They have to fill the ZRCOEFPV.f and M5COEFPV.f subroutines which contains the correlation coefficients. ZRCOEFPV.f contains the mechanical model parameters for **ZRM5**, **ZR4** and **ZR4H600** and M5COEFPV.f contains the physical parameters attached to the material **ZRM5**.

### **COPERNIC characteristics**

<p><b>NSTRU nstr</b></p> <p><b>BURNUP brnp</b></p> <p><b>CONTP pcont</b></p> <p><b>FPOROS poros</b></p>	<p>: OPTIONAL keyword followed by an integer defining the number of the wall of the FUELCHAR element involved in the INTEGRATE directive. This keyword is used to indicate that the COPERNIC models are going to be used for this fuel wall.  When NSTRU is used the three following parameters are mandatory:</p> <p>: real number <math>&gt;0</math> defining the local burnup (MWJ/t).</p> <p>: real number <math>&gt;0</math> defining the contact pressure between pellet and cladding (Pa).</p> <p>: real number <math>&gt;0</math> defining the volumic porosity used for the computation of pellet conductivity.</p>
---	--

### **Point neutron kinetics model characteristics**

One part of this model (coefficients COEPNLU, COEPRES, COEFM and COEFD) are defined in the FUELCHAR operator.

<p><b>NEUTRO</b></p> <p><b>POWNEUT PROFILE</b></p> <p><b>Ipn</b></p> <p><b>valpn</b></p> <p><b>Ipk</b></p> <p><b>valpk</b></p>	<p>: OPTIONAL keyword indicating that the point neutron kinetics model characteristics are going to be defined. This is followed by:</p> <p>: keyword to define the neutronic axial power profile. This is followed by:</p> <p>: keyword necessarily followed by as many pairs of (Ipn valpn) values as there are pn points used to define the segment.</p> <p>As many pairs of (Ipk valpk) values as required can be added to this list.</p> <p>: vector point included in the segment definition.</p> <p>: real number defining the value of the axial power profile at point Ipn.</p> <p>: vector point located inside the segment and not necessarily belonging to the mesh network of the element.</p> <p>: real number defining the value of the axial power profile at point Ipk.</p>
--	--

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 211/851

<b>POWRES PROFILE</b>	: keyword to define the residual axial power profile. This is followed by: : keyword necessarily followed by as many pairs of (Ip <sub>n</sub> val <sub>pn</sub> ) values as there are pn points used to define the segment. As many pairs of (Ip <sub>k</sub> val <sub>pk</sub> ) values as required can be added to this list.
<b>Ip<sub>n</sub> val<sub>pn</sub></b>	: vector point included in the segment definition.
<b>Ip<sub>k</sub></b>	: real number defining the value of the axial power profile at point P <sub>n</sub> .
<b>val<sub>pk</sub></b>	: vector point located inside the segment and not necessarily belonging to the mesh network of the element. : real number defining the value of the axial power profile at point P <sub>k</sub> .
<b>MODERAT PROFILE</b>	: keyword to define the characteristics of the axial anti-reactivity profile, due to moderator density variations. : keyword necessarily followed by as many pairs of (Ip <sub>n</sub> val <sub>mn</sub> ) values as there are pn points used to define the segment. As many pairs of (Ip <sub>k</sub> val <sub>mk</sub> ) values as required can be added to this list.
<b>Ip<sub>n</sub> val<sub>mn</sub></b>	: vector point object included in the segment definition. : real number defining the value of the axial anti-reactivity profile, due to moderator density variations at point Ip <sub>n</sub> .
<b>Ip<sub>k</sub></b>	: vector point located inside the segment and not necessarily belonging to the mesh network of the element.
<b>val<sub>mk</sub></b>	: real number defining the value of the axial anti-reactivity profile, due to moderator density variations at point Ip <sub>k</sub> . <b>N.B.</b> : The moderator anti-reactivity term is expressed in the following form: $ro = coefm \cdot valmn \cdot \langle r(t=t) - r(t=0) \rangle$ Where "r" is the moderator density and "coefm" is defined in the FUELCHAR operator.
<b>DOPPLER PROFILE</b>	: keyword to define the characteristics of the axial anti-reactivity profile due to the Doppler effect. : keyword necessarily followed by as many pairs of (Ip <sub>n</sub> val <sub>mn</sub> ) values as there are pn points used to define the segment. As many pairs of (Ip <sub>k</sub> val <sub>mk</sub> ) values as required can be added to this list.
<b>IP<sub>n</sub></b>	: vector point included in the segment definition.
<b>valdn</b>	: real number defining the value of the axial anti-reactivity profile, due to the Doppler effect at point Ip <sub>n</sub> .
<b>IP<sub>k</sub></b>	: vector point located inside the segment and not necessarily belonging to the mesh network of the element.
<b>valdk</b>	: real number defining the value of the axial anti-reactivity profile, due to the Doppler effect at point Ip <sub>k</sub> . <b>N.B.</b> : The Doppler anti-reactivity term is expressed in the following form: $ro = coefd \cdot valdn \cdot \langle \sqrt{T_f(t)} - \sqrt{T_f(t=0)} \rangle$ Where Tf is the mean temperature of the fuel (Kelvin), and coefd is defined in the FUELCHAR operator.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 212/851

<b>Example</b>
----------------

```

1) law1 =      LAW
               'RADIUS'   'POWER'
               0.D0        0.93504
               1.832D-3   0.95497
               2.591D-3   0.98539
               3.173D-3   1.01308
               3.664D-3   1.04059
               4.096D-3   1.06135 ;

fuel1 =       FUEL          hotcore    INTERNAL
               SEGMENT      A1         B1         C4         D5
               ISO           6          DIAM        0.0D0     8.192D-3
               UO2

               IRRAFUEL
               WZUO        0.31578
               LAW         law1

               GAP          91.0 D-6
               CLADDING    ZRCEA
                           RM         4.4469 D-3 ;

fuel2 =       FUEL          hotcore    INTERNAL
               SEGMENT      A1 B1 C4 D5
               ISO           6          DIAM        0.0D0     8.192D-3
               UO2

               NEWFUEL
               WZUO        0.31578
               LAW         law1

               GAP          91.0 D-6
               CLADDING    ZRPHEBUS
                           RM         4.4469 D-3

               NEUTRO
               POWNEUT
                           PROFILE    A1         0.876
                           B1         0.785
                           C4         0.889
                           D5         0.008
                           N1         0.445

               POWRES
                           PROFILE    A1         0.876
                           B1         0.785
                           C4         0.889
                           D5         0.008
                           N1         0.445

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 213/851

MODERAT

PROFILE	A1	0.876
	B1	0.785
	C4	0.889
	D5	0.008

DOPPLER

PROFILE	A1	.0876
	B1	0.995
	C4	0.669
	D5	0.328
	N2	0.675

;

2) fuel3 =	FUEL	hotcore	INTERNAL	
	SEGMENT	A1	B1	C4
	ISO	6	DIAM	0.0D0
	UO2			8.192D-3
		SCARFUEL	CP1	
		WZUO	0.31578	
		LAW	law1	
	GAP	91.0 D-6		
	CLADDING	ZRCEA		
		RM	4.4469 D-3 ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 214/851

64

## FUELPLAQ OPERATOR

The **FUELPLAQ** operator creates, in data block, a **FUELPLAQ** object by defining its characteristics. A **FUELPLAQ** object is a fuel wall which can be either cylinder or plane but with no deformation.

A **FUELPLAQ** element is defined on segments delimited by 2 vector points ; these 2 vector points must belong to the axial element. A mesh can appear only once in a **FUELPLAQ** element. The **FUELPLAQ** element contains all the segments that are declared within the **FUELPLAQ** operator.

The **FUELPLAQ** operator can be used for four types of applications:

1. a standard Pressurized Water Reactor **PWR**,
2. a specific Navy power Plant studies. In that case, **DENSITY** keyword has to be defined in the **CORE** operator,
3. a High Temperature gas cooled Reactor **HTR**. In that case, the keyword **HTR** has to be defined,
4. a liquid-metal-cooled Fast Neutron Reactor **FNR**. In that case, the keyword **FNR** has to be defined.

### N.B :

1. Note on user supplied materials: In CATHARE2, 6 + 50 user defined materials can be defined in a special subroutine FWMAXX or FWMAYY respectively, with material index (INDMAT) given as argument.

The name of the first group of 6 user defined materials must begin with 'XXXXXXX' and the last character is an integer between 1 and 6, ie "XXXXXXX1" (*INDMAT* = 28) to "XXXXXXX6" (*INDMAT* = 33) (see FWMAXX subroutine).

The name of the second group of 50 user defined materials must begin with "YYYYYY" and the two last characters are integers between 01 and 50, ie "YYYYYY01" (*INDMAT* = 38) to "YYYYYY50" (*INDMAT* = 87) (see FWMAYY subroutine).

10 other materials can be defined in the data block using MATERIAL operator. The properties of these materials are defined as polynomial functions of the wall temperature in a given range of temperature.

2. A **FUELPLAQ** wall can only be defined on an axial hydraulic element
3. When option **HTR** (or **FNR**) is used associated to a point kinetics computation, the **CORE** object must also be defined with **HTR** (or **FNR**) option (see **CORE** operator).

### Associated Keywords

POWER, XNEULIST, XNEULISX, PNRSHAPE, PNRSHAPX, PRESHAPE, PRESHAPX, XRESLIST, XRESLISX, MODXRES, MATERIAL, RJH, VALUE FOR FUELPLAQ, WRITE FOR FUELPLAQ

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 215/851

Syntax
--------

## 64.1 PWR and NP Navy power Plant applications

```

p1 =      FUELPLAQ elem
          INTERNAL (or      EXTERNAL)
          PLANE   (or      CYLINDER)
          (RJHCHANL or      PNCHANL)
          (POWNEUT coefpow
          POWRESI coefresi
          LAWNEUT lawneut
          LAWRESI lawresi )

          COEFKNEU coefkneu
          COEFKRES coefkres
          COEFKM  coefkm
          COEFKD   coefkd
          (COEFKB  (DENSITY)
           coefkba  coefkbb   coefkbc )
          or       (FCOEFKD (DENSITY)
           coefkba  coefkbb   )
          (XNEUT   xneut    )
          (XRES    xres     )

          LAW      law

          (NCHANNEL nchannel  )

SEGMENT Pi      Pj
          material1
          DATA nm1
          DIAM (or      THICK)
                 d1      d2      ...
                                         dnm1+1
          or
          DATA nm1
                 DINI   (or      THINI)
                 d11    d21    ...
                                         dnm11+1
                 DEND   (or      THEND)
                 d12    d22    ...
                                         dnm12+1
          or
          ISO   nm1
          DIAM (or      THICK)
                 di      dext
          or
          ISO   nm1
                 DINI   (or      THINI)
                 di1    dext1

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 216/851

		<b>DEND</b>	(or	<b>THEND)</b>
		di2	dext2	
	<b>(RESIST</b>	<b>VALUE</b>	Hres	or
			<b>RIGHT</b>	or
	or	<b>MODEL</b>	<b>YYYYYYij</b>	<b>LEFT</b>
			(HEATFLUX	or
			<b>RIGHT</b>	or
		(material2	...	<b>TEMP</b> )
				<b>LEFT)</b>
<b>MEDIUM</b>	miq 1			
<b>HPERIM</b>	<b>POINT</b>	P1	peri1	
		P2	peri2	
		(P3	<b>AND</b>	P4)
			...	peri3
	or			
	<b>CONST</b>	peri		
<b>(MULTH</b>	xhint	xhext	)	
<b>PROFILE</b>	<b>ZKPOWNR</b>	puis1		
		or	list1	
		or	<b>PINI</b>	puisini
			<b>PEND</b>	puisend
	<b>ZKPOWRS</b>	puis2		
		or	list2	
		or	<b>PINI</b>	puisini
			<b>PEND</b>	puisend
	<b>AZKMOD</b>	az3		
		or	list3	<b>(ABSMESH)</b>
		or	<b>AZINI</b>	azini
			<b>AZEND</b>	azend
	<b>AZKDOP</b>	az4		
		or	list4	<b>(ABSMESH)</b>
		or	<b>AZINI</b>	azini
			<b>AZEND</b>	azend
	<b>(AZKBOR</b>	az5		
		or	list5	<b>(ABSMESH)</b>
		or	<b>AZINI</b>	azini
			<b>AZEND</b>	azend
				)
<b>(LOSS</b>				
	<b>HEXT</b>	hext1	or	listh1
	<b>TEXT</b>	text1	or	listt1
or	<b>HINI</b>	hexini	<b>HEND</b>	hexfin
	<b>TINI</b>	texini	<b>TEND</b>	texfin
or	<b>PHIEXT</b> <sup>1</sup>	phiext1	or	list1
or	<b>PHIINI</b>	phiini	<b>PHIEND</b>	phifin
				)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 217/851

(SEGMENT Pk Pl  
...);

## 64.2 HTR application

p1 =	<b>FUELPLAQ</b>	elem	<b>HTR</b>	
	<b>INTERNAL</b>	(or		<b>EXTERNAL)</b>
	<b>PLANE</b>	(or		<b>CYLINDER)</b>
	<b>(RJHCHANL</b>	or		<b>PNCHANL)</b>
	<b>(POWNEUT</b>	coefpow		
	<b>POWRESI</b>	coefresi		
	<b>LAWNEUT</b>	lawneut		
	<b>LAWRESI</b>	lawresi )		
	<b>COEFKNEU</b>	coefkneu		
	<b>COEFKRES</b>	coefkres		
	<b>COEFKM</b>	coefkm		<b>NOAVERAG</b>
or	<b>FCOEFKM</b>	coefkm1	coefkm2	
		coefkm3	coefkm4	
	<b>COEFKD</b>	coefkd		<b>NOAVERAG</b>
or	<b>FCOEFKD</b>	coefkd1	coefkd2	
		coefkd3	coefkd4	
	<b>COEFKR</b>	coefkr		<b>NOAVERAG</b>
or	<b>FCOEFKR</b>	coefkr1	coefkr2	
		coefkr3	coefkr4	
	<b>COEFKV</b>	coefkv		<b>NOAVERAG</b>
or	<b>(FCOEFKV</b>	coefkv1	coefkv2	
		coefkv3	coefkv4)	
	<b>COEFKFA</b>	coefkfa		<b>NOAVERAG</b>
or	<b>(FCOEFKFA</b>	coefkfa1	coefkfa2	
		coefkfa3	coefkfa4)	
	<b>(XNEUT</b>	xneut	)	
	<b>(XRES</b>	xres	)	
	<b>LAW</b>	law		
	<b>(NCHANNEL</b>	nchannel	)	
	<b>(AXICOND</b>	)		
	<b>SEGMENT</b>	Pi	Pj	
		material1		
	<b>DATA</b>	nm1		
	<b>DIAM</b>	(or	<b>THICK</b> )	
		d1	d2	...
				dnm1+1

<sup>1</sup>phiext1 > 0 means given to the FUELPLAQ wall, < 0 means lost by the FUELPLAQ wall

<b>DATA</b>	nm1			
	<b>DINI</b>	(or	<b>THINI)</b>	
	d11	d21	...	dnm11+
	<b>DEND</b>	(or	<b>THEND)</b>	
	d12	d22	...	dnm12+1
or				
<b>ISO</b>	nm1			
<b>DIAM</b>	(or	<b>THICK)</b>		
	di	dext		
or				
<b>ISO</b>	nm1			
	<b>DINI</b>	(or	<b>THINI)</b>	
	di1	dext1		
	<b>DEND</b>	(or	<b>THEND)</b>	
	di2	dext2		
<b>(RESIST</b>	<b>VALUE</b>	Hres	or	reslit
		<b>RIGHT</b>	or	<b>LEFT</b>
or	<b>MODEL</b>	<b>YYYYYYij</b>		
		<b>(HEATFLUX</b>	or	<b>TEMP )</b>
		<b>RIGHT</b>	or	<b>LEFT)</b>
(material2	...)			
dop1	<b>FRACNEU</b>	fracneu1		
fracres1	<b>(MODERAT</b>	mod2 )	)	
<b>(MODERAT</b>	mod1	<b>FRACNEU</b>	fracneu2 )	
<b>(REFLECT</b>	refl1	<b>FRACNEU</b>	fracneu3	
<b>POINT</b>	<b>FRACKR</b>	frackr1	)	
	P1	peri1		
	P2	peri2		
	(P3	<b>AND</b>	P4)	peri3
	...			
or				
<b>CONST</b>	peri			
xhint	xhex1	)		
<b>ZKPOWRN</b>	puis1			
	or	list1		
	or	<b>PINI</b>	puisini	
		<b>PEND</b>	puisend	
<b>ZKPOWRS</b>	puis2			
	or	list2		
	or	<b>PINI</b>	puisini	
		<b>PEND</b>	puisend	
<b>AZKMOD</b>	az3			
	or	list3	<b>(ABSMESH)</b>	
	or	<b>AZINI</b>	azini	
		<b>AZEND</b>	azend	
<b>AZKDOP</b>	az4			
	or	list4	<b>(ABSMESH)</b>	
	or	<b>AZINI</b>	azini	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 219/851

			<b>AZEND</b>		azend
or	<b>(AZKREF</b>	az5			
		or	list5		(ABSMESH)
		or	<b>AZINI</b>		puisini
			<b>AZEND</b>		puisend )
	<b>(AZKVOID</b>	az6			
		or	list5		(ABSMESH)
		or	<b>AZINI</b>		puisini
			<b>AZEND</b>		puisend )
	<b>(LOSS</b>				
	<b>(RADEXT</b>				
			<b>EEXT</b>	eext1	or
			(TEXT	text1	liste1
		or	<b>EINI</b>	eexini	or
			(TINI	texini	list1 )
and / or			<b>HEXT</b>	hext1	listt1
			<b>TEXT</b>	text1	
	or	<b>HINI</b>	hexini	<b>HEND</b>	hexfin
		<b>TINI</b>	texini	<b>TEND</b>	texfin )
	or	<b>PHIEXT</b> <sup>1</sup>	phiext1	or	list1
	or	<b>PHIINI</b>	phiini	<b>PHIEND</b>	phifin )
	<b>(SEGMENT</b>	Pk	Pl		
		...);			

## 64.3 FNR application

p1 =	<b>FUELPLAQ</b>	elem	<b>FNR</b>	comb	
		<b>INTERNAL</b>	(or	<b>EXTERNAL</b> )	
		<b>PLANE</b>	(or	<b>CYLINDER</b> )	
		<b>(RJHCHANL</b>	or	<b>PNCHANL</b> )	
		<b>(POWNEUT</b>	coefpow		
		<b>POWRESI</b>	coefresi		
		<b>LAWNEUT</b>	lawneut		
		<b>LAWRESI</b>	lawresi )		
		<b>COEFKNEU</b>	coefkneu		
		<b>COEFKRES</b>	coefkres		
		<b>(COEFKD</b>	coefkd	<b>(NOAVERAG)</b>	
or		<b>FCOEFKD</b>	coefkd1	coefkd2	
			coefkd3	coefkd4	coefkd5)
		<b>(COEFKV</b>	coefkd	<b>(NOAVERAG)</b>	

<sup>1</sup>phiext1 > 0 means given to the FUELPLAQ wall, < 0 means lost by the FUELPLAQ wall

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 220/851

or	<b>FCOEFKV</b>	coefkv1	coefkv2		
		coefkv3	coefkv4)		
or	<b>(COEFKFR</b>	coefkfr	<b>(NOAVERAG)</b>		
	<b>FCOEFKFR</b>	coefkr1	coefkr2		
		coefkr3	coefkr4)		
or	<b>(COEFKFA</b>	coefkfa	<b>(NOAVERAG)</b>		
	<b>FCOEFKFA</b>	coefkfa1	coefkfa2		
		coefkfa3	coefkfa4)		
or	<b>(COEFKCR</b>	coefkcr	<b>(NOAVERAG)</b>		
	<b>FCOEFKCR</b>	coefkcr1	coefkcr2		
		coefkcr3	coefkcr4)		
or	<b>(COEFKCA</b>	coefkca	<b>(NOAVERAG)</b>		
	<b>FCOEFKCA</b>	coefkca1	coefkca2		
		coefkca3	coefkca4)		
or	<b>(COEFKDR</b>	coefkdr	<b>(NOAVERAG)</b>		
	<b>FCOEFKDR</b>	coefkdr1	coefkdr2		
		coefkdr3	coefkdr4)		
or	<b>(COEFKDA</b>	coefkda	<b>(NOAVERAG)</b>		
	<b>FCOEFKDA</b>	coefkda1	coefkda2		
		coefkda3	coefkda4)		
	<b>(COEFKP</b>	coefkp	)		
	<b>(XNEUT</b>	xneut	)		
	<b>(XRES</b>	xres	)		
	<b>LAW</b>	law			
	<b>(NCHANNEL</b>	nchannel	)		
	<b>(AXICOND</b>	)			
<b>SEGMENT</b>	Pi	Pj			
	material1				
	<b>DATA</b>	nm1			
	<b>DIAM</b>	(or	<b>THICK)</b>		
		d1	d2	...	dnm1+1
or	<b>DATA</b>	nm1			
		<b>DINI</b>	(or	<b>THINI)</b>	
		d11	d21	...	dnm11+1
		<b>DEND</b>	(or	<b>THEND)</b>	
		d12	d22	...	dnm12+1
or	<b>ISO</b>	nm1			
	<b>DIAM</b>	(or	<b>THICK)</b>		
		di	dext		
or	<b>ISO</b>	nm1			
		<b>DINI</b>	(or	<b>THINI)</b>	
		d11	dext1		
		<b>DEND</b>	(or	<b>THEND)</b>	
		d12	dext2		

	( <b>FREE</b> <b>RESIST</b>	nray VALUE <b>RIGHT</b> or <b>MODEL</b>	or Hres or <b>YYYYYYij</b> <b>(HEATFLUX</b> <b>RIGHT</b>	nray listfree) or <b>LEFT</b> or <b>TEMP</b> ) or	
	(material2	...)			<b>LEFT)</b>
<b>(DOPPLER</b> <b>FRACRES</b>	dop1 fracres1 or <b>(REFLECT</b> <b>(HEXDUCT</b>	<b>FRACNEU</b> ) refl1 hex1	fracneu1 <b>FRACNEU</b> <b>(CONTPAD</b>	fracneu3) <b>FRACNEU</b>	fracneu4)
<b>HPERIM</b>	<b>POINT</b>	P1 P2 (P3 ... or <b>CONST</b>	peri1 peri2 <b>AND</b>	P4)	peri3
<b>PROFILE</b>	<b>(ENRICH</b> or <b>(TAUREMP</b> or <b>ZKPOWRN</b>	enr1 enr_list tauremp1 tauremp_list puis1 or or	) list1 <b>PINI</b> <b>PEND</b>	puisini puisend	
<b>ZKPOWRS</b>		puis2 or or	list2 <b>PINI</b> <b>PEND</b>	puisini puisend	
<b>AZKDOP</b>		az4 or or	list4 <b>AZINI</b> <b>AZEND</b>	( <b>ABSMESH</b> ) az4ini az4end	
<b>AZKFUER</b>		az7 or or	list7 <b>AZINI</b> <b>AZEND</b>	( <b>ABSMESH</b> ) az7ini az7end	
<b>AZKFUEA</b>		az8 or or	list8 <b>AZINI</b> <b>AZEND</b>	( <b>ABSMESH</b> ) az8ini az8end	
<b>(AZKVOID</b>		az6 or or	list6 <b>AZINI</b> <b>AZEND</b>	( <b>ABSMESH</b> ) az6ini az6end	)
<b>(AZKCLAR</b>		az9 or or	list9 <b>AZINI</b> <b>AZEND</b>	( <b>ABSMESH</b> ) az9ini az9end	)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 222/851

	<b>(AZKCLAA</b>	az10 or or	list10 <b>AZINI</b> <b>AZEND</b>	<b>(ABSMESH)</b> az10ini az10end )
	<b>(AZKDUCR</b>	az11 or or	list11 <b>AZINI</b> <b>AZEND</b>	<b>(ABSMESH)</b> az11ini az11end )
	<b>(AZKDUCA</b>	az12 or or	list12 <b>AZINI</b> <b>AZEND</b>	<b>(ABSMESH)</b> az12ini az12end )
	<b>(LOSS</b>			
	<b>(RADEXT</b>			
		<b>EEXT</b> ( <b>TEXT</b> or <b>EINI</b> ( <b>TINI</b>	eext1 text1 eexini texini	or or <b>EEND</b> <b>TEND</b>
and / or		<b>HEXT</b> <b>TEXT</b>	hext1 text1	listh1 listt1
	or	<b>HINI</b> <b>TINI</b>	hexini texini	<b>HEND</b> <b>TEND</b>
	or	<b>PHIEXT</b> <sup>1</sup>	phiext1	or list1
	or	<b>PHIINI</b>	phiini	<b>PHIEND</b> phifin )
	<b>(SEGMENT</b>	Pk	Pl	...) ;

**elem**

: axial element

**comb**

: **FNR** application only – MANDATORY only if a Doppler media is defined. In that case, COEFKRES keyword is also mandatory. In case the Doppler media is not defined, COEFKRES keyword is optional.

**INTERNAL**

Keyword to indicate the type of fuel material, among OXID, NITRATE and METAL : keyword indicating that the **FUELPLAQ** wall is internal with respect to the flow. In the cases where the **FUELPLAQ** wall is external with respect to the flow, INTERNAL will be replaced by the keyword EXTERNAL.

**PLANE**

: keyword indicating that the **FUELPLAQ** wall is a plane wall. In this case the keyword used to define the radial meshing is THICK (THINI, THEND).

**or CYLINDER**

: keyword indicating that the **FUELPLAQ** wall is a cylinder wall. In this case the keyword used to define the radial meshing is DIAM (DINI, DEND).

<sup>1</sup>phiext1 > 0 means given to the FUELPLAQ wall, < 0 means lost by the FUELPLAQ wall

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 223/851</a>

<b>RJHCHANL</b> <b>or</b> <b>PNCHANL</b>	: OPTIONAL keyword to indicate that the user applies the physical closure relationships of the <b>RJH</b> (Reactor Jules Horowitz) or of the <b>NP</b> (Nuclear Propulsion private libraries) to this wall. <b>Remark:</b> To use one of these models, the user must verify that: <ul style="list-style-type: none"> <li>• He has activated the same keyword in the associated axial hydraulic element,</li> <li>• If this <b>RJH/NP</b> wall is not as long as the associated hydraulic element, he has defined another <b>RJH/NP</b> wall(s) to complete the empty area,</li> <li>• There is one and only one <b>RJH/NP</b> mesh wall for each hydraulic mesh.</li> </ul>
<b>POWNEUT</b> <b>coefpow</b>	: keyword followed by a real number ( $W > 0$ ), which defines the reference neutron power released in the fuel. <b>N.B :</b> OPTIONAL keyword to use with the directive STOPNEUT.
<b>POWERESI</b> <b>coefresi</b>	: keyword followed by a real number ( $W > 0$ ), which defines the reference residual power released in the fuel. <b>N.B :</b> OPTIONAL keyword to use with the directive STOPNEUT.
<b>LAWNEUT</b> <b>lawneut</b>	: keyword followed by a 'TIME' 'POWER' law-type object defining a time depending profile, i.e., a law expressing the neutron power variation (real number $\geq 0$ ) (non dimensional) as a function of time (real number $\geq 0$ ). (s). <b>N.B 1 :</b> OPTIONAL keyword to use with the directive STOPNEUT. <b>N.B 2 :</b> interpolation used is logarithmic.
<b>LAWRESI</b> <b>lawresi</b>	: keyword followed by a 'TIME' 'POWER' law-type object defining a time depending profile, i.e. a law expressing the residual power variation (real number $\geq 0$ ). (non dimensional) as a function of time (real number $\geq 0$ ). (s). <b>N.B 1 :</b> OPTIONAL keyword to use with the directive STOPNEUT. <b>N.B 2 :</b> interpolation used is logarithmic.
<b>COEFKNEU</b> <b>coefkneu</b>	: keyword followed by a real number $> 0$ defining the neutronic power coefficient for the <b>FUELPLAQ</b> wall, that is the peak factor on the neutronic power received by the FUELPLAQ with respect to the nominal core neutronic power. <b>N.B 1 :</b> When there is only one <b>FUELPLAQ</b> wall, coefkneu = 1. <b>N.B 2 :</b> If nfuels FUELPLAQ receive the same nominal power, define coefkneu = 1 for each FUELPLAQ and the equivalent power will be automatically multiplied by coefkneu / (nfuels * coefkneu)
<b>COEFKRES</b> <b>coefkres</b>	: keyword followed by a real number $> 0$ defining the residual power coefficient for the <b>FUELPLAQ</b> wall, that is peak factor on the residual power received by the FUELPLAQ with respect to the nominal core residual power. FNR application - COEFKRES keyword is mandatory only when the Doppler media is defined. If not, the keyword is optional.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 224/851

**COEFKM**  
**coefkm**

: keyword followed by a real number > 0 defining the **anti-reactivity** (R in \$) coefficient resulting from the moderator density variations for the **FUELPLAQ** wall (in \$) if **PWR**. The moderator effect anti-reactivity term is expressed in the following form :

- moderator density variations for the **FUELPLAQ** wall (in \$) if **PWR**. The moderator effect anti-reactivity term is expressed in the following form :

$$R = -\text{coefkm} \cdot [\rho(t=t) - \rho(t=0)]$$

- moderator temperature variations for the **FUELPLAQ** wall (in \$) if **HTR**. The moderator effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkm} \cdot [T_{\text{moderator}}(t=t) - T_{\text{moderator}}(t=0)]$$

or **FCOEFKM**  
**coefkm1 coefkm2**  
**coefkm3 coefkm4**

: **HTR** application only. It describes the **anti-reactivity coefficient** (R in \$) as a function of **the moderator temperature (T in K)** through its differential efficiency :

$$\frac{dR}{dT} = \frac{\text{coefkm1}}{T} + \text{coefkm2} + \text{coefkm3} \cdot T + \text{coefkm4} \cdot T^2$$

*The keyword is followed by four real positive numbers (R is an increasing function of T). The default value of these coefficients is 0.*

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each **FUELPLAQ** object defined on the element.

**COEFKD**  
**coefkd**

: keyword followed by a real number > 0 defining the **anti-reactivity** coefficient resulting from the Doppler effect for the segment (in \$). The Doppler anti-reactivity term is expressed in the following form :

- If **PWR** :

$$R = \text{coefkd} * [\sqrt{T_{UO_2}(t=t)} - \sqrt{T_{UO_2}(t=0)}]$$

- If **FNR** or **HTR** :

$$R = \text{coefkd} * [\ln(T_{UO_2}(t=t)) - \ln(T_{UO_2}(t=0))]$$

The variation of the anti-reactivity coefficient along the **FUELPLAQ** wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefkd anti-reactivity coefficient should be representative of the wall lineic anti-reactivities (in \$/m).
- a profile that will be automatically normalized, in the other case.

or **FCOEFKD**  
**coefkd1 coefkd2**  
**coefkd3 coefkd4**  
**coefkd5**

: **HTR** and **FNR** applications only.

It describes the **anti-reactivity coefficient** (R in \$) as a function of **the UO<sub>2</sub> mean temperature (T in K)** through its differential efficiency :

$$\frac{dR}{dT} = \frac{\text{coefkd1}}{T} + \text{coefkd2} + \text{coefkd3} \cdot T + \text{coefkd4} \cdot T^2 + \text{coefkd5} \cdot T^{-1/2}$$

*The keyword is followed by five real positive numbers (R is an increasing function of T). The default value of these coefficients is 0.*

The coefficient is calculated at each point of the axial element and may be different for each **FUELPLAQ** object defined on the element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 225/851

**COEFKR**  
**coefkr**

: **HTR** application only.

Keyword followed by a real number < 0 defining the anti-reactivity coefficient resulting from the reflector effect for the segment (in \$). The reflector effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkr} \cdot [\mathbf{T}_{\text{reflector}}(t = t) - \mathbf{T}_{\text{reflector}}(t = 0)]$$

or **FCOEFKR**  
**coefkr1 coefkr2**  
**coefkr3 coefkr4**

: **HTR** application only

It describes the **anti-reactivity coefficient** (R in \$) as a function of the **reflector temperature** (T in K) through its differential efficiency :

$$\frac{dR}{dT} = \frac{\text{coefkr1}}{T} + \text{coefkr2} + \text{coefkr3} \cdot \mathbf{T} + \text{coefkr4} \cdot \mathbf{T}^2$$

*The keyword is followed by four real positive numbers (R is an increasing function of T). The default value of these coefficients is 0.*

The coefficient is calculated at each point of the axial element and may be different for each FUELPLAQ object defined on the element.

**COEFKV**  
**coefkv**

: **HTR** and **FNR** applications only – OPTIONAL keyword

Followed by a real number defining the **anti-reactivity** coefficient resulting from fluid density variations in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkv} \cdot [\mathbf{p}(t = t) - \mathbf{p}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefkv anti-reactivity coefficient should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case.

or **FCOEFKV**  
**coefkv1 coefkv2**  
**coefkv3 coefkv4**

: **HTR** and **FNR** applications only – OPTIONAL keyword

It describes the **anti-reactivity coefficient** (R in \$) as a function of the fluid density ( $\rho$  in kg/m<sup>3</sup>),through its differential efficiency :

$$\frac{dR}{d\rho} = \text{coefkv1} \cdot \rho + \text{coefkv2} + \text{coefkv3} \cdot \rho + \text{coefkv4} \cdot \rho^2$$

*The keyword is followed by four real positive numbers (R is a decreasing function of T) numbers. The default value of these coefficients is 0.*

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element.

		<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>		Page 226/851

## COEFKFR coefkfr

: **FNR** application only - OPTIONAL keyword

Followed by a real number defining the **anti-reactivity** coefficient resulting from fuel radial thermal expansion due to fluid temperature variations (when the fuel is in contact with the cladding) in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkfr} \cdot [\text{T}(t = t) - \text{T}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case.

## or FCOEFKFR coefkfr1 coefkfr2 coefkfr3 coefkfr4

: **FNR** application only – OPTIONAL keyword

It describes the **anti-reactivity coefficient** (R in \$) resulting from the fuel radial thermal expansion as a function the fluid temperature (T in K), through its differential efficiency :

$$\frac{dR}{dT} = \frac{\text{coefkfr1}}{T} + \text{coefkfr2} + \text{coefkfr3} \cdot T + \text{coefkfr4} \cdot T^2$$

*The keyword is followed by four real numbers. The default value of these coefficients is 0.*

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element

## COEFKFA coefkfa

: **HTR** and **FNR** application only - OPTIONAL keyword

Followed by a real number defining the **anti-reactivity** coefficient resulting from fuel axial thermal expansion in the **FUELPLAQ** wall zone (in \$) due to :

- the fluid temperature variations when the fuel is in contact with the cladding.
- the radial temperature of the fuel pin or the average temperature of the fuel pin radial layer if the keyword FREE is given in the SEGMENT definition.

The thermal expansion anti-reactivity term is expressed in the following form :

$$R = \text{coefkfa} \cdot [\text{T}(t = t) - \text{T}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 227/851

or **FCOEFKFA**  
**coefkfa1 coefkfa2**  
**coefkfa3 coefkfa4**

: **HTR** and **FNR** application only – OPTIONAL keyword  
It describes the **anti-reactivity coefficient** ( $R$  in \$) resulting from the fuel axial thermal expansion as a function of the fluid temperature ( $T$  in K), through its differential efficiency :

$$\frac{dR}{dT} = \frac{coefkfa1}{T} + coefkfa2 + coefkfa3 \cdot T + coefkfa4 \cdot T^2$$

It is either function of the fluid temperature ( $T$  in K) or, if FREE keyword is given in the SEGMENT definition, function of the radial temperature of the fuel pin.

The keyword is followed by four real numbers. The default value of these coefficients is 0.

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element.

**COEFKCR**  
**coefkcr**

: **FNR** application only - OPTIONAL keyword  
Followed by a real number defining the **anti-reactivity** coefficient resulting from cladding radial thermal expansion due to fluid temperature variations in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form :

$$R = coefkcr \cdot [T(t = t) - T(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case.

or **FCOEFKCR**  
**coefkcr1 coefkcr2**  
**coefkcr3 coefkcr4**

: **FNR** application only – OPTIONAL keyword  
It describes the **anti-reactivity coefficient** ( $R$  in \$) resulting from the cladding radial thermal expansion as a function the fluid temperature ( $T$  in K), through its differential efficiency :

$$\frac{dR}{dT} = \frac{coefkcr1}{T} + coefkcr2 + coefkcr3 \cdot T + coefkcr4 \cdot T^2$$

The keyword is followed by four real numbers. The default value of these coefficients is 0.

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 228/851

**COEFKCA**  
**coefkca**

: **FNR** application only - OPTIONAL keyword  
 Followed by a real number defining the **anti-reactivity** coefficient resulting from the cladding axial thermal expansion due to fluid temperature variations in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkca} \cdot [\text{T}(t = t) - \text{T}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case

**or FCOEFKCA**  
**coefkca1 coefkca2**  
**coefkca3 coefkca4**

: **FNR** application only – OPTIONAL keyword  
 It describes the **anti-reactivity coefficient** (R in \$) resulting from the cladding axial thermal expansion as a function the fluid temperature (T in K), through its differential efficiency :

$$\frac{dR}{dp} = \frac{\text{coefkca1}}{\text{T}} + \text{coefkca2} + \text{coefkca3} \cdot \text{T} + \text{coefkca4} \cdot \text{T}^2$$

The keyword is followed by four real numbers. The default value of these coefficients is 0.

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element

**COEFKDR**  
**coefkdr**

: **FNR** application only - OPTIONAL keyword  
 Followed by a real number defining the **anti-reactivity** coefficient resulting from the duct radial thermal expansion due to fluid temperature variations in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkdr} \cdot [\text{T}(t = t) - \text{T}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case

**or FCOEFKDR**  
**coefkdr1 coefkdr2**  
**coefkdr3 coefkdr4**

: **FNR** application only – OPTIONAL keyword  
 It describes the **anti-reactivity coefficient** (R in \$) resulting from the duct radial thermal expansion as a function the wall duct temperature (T in K), through its differential efficiency :

$$\frac{dR}{dp} = \frac{\text{coefkdr1}}{\text{T}} + \text{coefkdr2} + \text{coefkdr3} \cdot \text{T} + \text{coefkdr4} \cdot \text{T}^2$$

The keyword is followed by four real numbers. The default value of these coefficients is 0.

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 229/851

**COEFKDA**  
**coefkda**

: **FNR** application only - OPTIONAL keyword  
Followed by a real number defining the **anti-reactivity** coefficient resulting from the duct axial thermal expansion due to fluid temperature variations in the **FUELPLAQ** wall zone (in \$). The void effect anti-reactivity term is expressed in the following form:

$$R = \text{coefkda} \cdot [\textcolor{blue}{T}(t = t) - \textcolor{blue}{T}(t = 0)]$$

The variation of the anti-reactivity coefficient along the FUELPLAQ wall will be taken into account later (see PROFILE keyword) by giving :

- a list of multiplicative factors, if NOAVERAG is used : the product of these factors by the coefk anti-reactivity should be representative of the wall lineic anti-reactivities (in \$/m)
- a profile that will be automatically normalized, in the other case

**or FCOEFKDA**  
**coefkda1** **coefkda2**  
**coefkda3** **coefkda4**

: **FNR** application only – OPTIONAL keyword  
It describes the **anti-reactivity coefficient** (R in \$) resulting from the duct axial thermal expansion as a function the wall duct temperature (T in K), through its differential efficiency :

$$\frac{dR}{dT} = \frac{\text{coefkda1}}{\textcolor{blue}{T}} + \text{coefkda2} + \text{coefkda3} \cdot \textcolor{blue}{T} + \text{coefkda4} \cdot \textcolor{blue}{T}^2$$

The keyword is followed by four real numbers. The default value of these coefficients is 0.

This anti-reactivity effect is calculated at each point of the axial element, and may be different for each FUELPLAQ object defined on the element

**COEFKP**  
**coefkp**

: **FNR** application only - OPTIONAL keyword  
Followed by a real number defining the **anti-reactivity** coefficient resulting from changes in the core geometry (depending on the fact that the contact pads are in contact or not ) in the **FUELPLAQ** wall zone (in \$), due to variation of average temperature difference between contact pads and core support plate (see also **CORE** operator, keyword CONTPAD). The void effect anti-reactivity term is expressed in the following form :

$$R = \text{coefkp} \cdot [\Delta \textcolor{blue}{T}(t = t) - \Delta \textcolor{blue}{T}(t = 0)]$$

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 230/851

<b>COEFKB (DENSITY)</b> <b>coefkba coefkbb</b> <b>coefkbc</b>	<p>: <b>COEFKB</b> keyword describes the anti-reactivity resulting from boron effect using the <u>integration</u> method.</p> <p><b>DENSITY</b> keyword is an optional keyword which describes the anti-reactivity (R in \$) as a function of <u>the liquid density of the fluid</u> and <u>the soluble boron concentration</u> (Cb) in mass of boron (kg) per mass of liquid water (kg) by its differential. This option has to be used for special applications such as navy power plant safety studies.</p> $\frac{dR}{dCb} = coefkba \cdot \rho_L + coefkbb \cdot \rho_L^2 \cdot Cb$ <p>By default, (without DENSITY keyword), the antireactivity (R in \$) is computed as a function of <u>the soluble boron concentration</u> (Cb) in mass of boron (kg) per mass of liquid water (kg) by its differential.</p> $\frac{dR}{dCb} = coefkba + coefkbb2 \cdot Cb$ <p><b>coefkba, coefkbb</b> are two real positive numbers (R is an increasing function of Cb)  <b>coefkc</b> is a real number <math>&gt; 0</math> defining the radial anti-reactivity coefficient.  <b>Note:</b> when the integration method is used, the axial anti-reactivity coefficients have to be given (see <b>AZKBOR</b> keyword)</p>
<b>or FCOEFKB (DENSITY)</b> <b>coefkba coefkbb</b>	<p>: <b>FCOEFKB</b> keyword describes the anti-reactivity resulting from boron effect using the <u>function</u> method.</p> <p><b>DENSITY</b> keyword is an optional keyword which describes the anti-reactivity (R in \$) as a function of <u>the liquid density of the fluid</u> and <u>the soluble boron concentration</u> (Cb) in mass of boron (kg) per mass of liquid water (kg) by its differential. This option has to be used for special applications such as navy power plants safety studies.</p> $\frac{dR}{dCb} = coefkba \cdot \rho_L + coefkbb \cdot \rho_L^2 \cdot Cb$ <p>By default, (without DENSITY keyword), the antireactivity (R in \$) is computed as a function of <u>the soluble boron concentration</u> (Cb) in mass of boron (kg) per mass of liquid water (kg) by its differential.</p> $\frac{dR}{dCb} = coefkba + coefkbb2 \cdot Cb$ <p><b>coefkba, coefkbb</b> are two real positive numbers (R is an increasing function of Cb)  <b>coefkc</b> is a real number <math>&gt; 0</math> and <math>&lt; 1</math>. which defines the fraction of neutron power released in the fuel.  <b>N.B :</b> the keyword is OPTIONAL in case of <b>HTR</b> application.</p>
<b>XRES xres</b>	<p>: OPTIONAL keyword followed by a real number <math>&gt; 0</math>. and <math>&lt; 1</math>. which defines the fraction of residual power released in the fuel. Default value is 1.</p>
<b>LAW law</b>	<p>: keyword followed by a 'RADIUS' 'POWER' law-type object defining a radial depending profile, i.e. a law expressing the power variation (real number <math>\geq 0</math>) (non dimensional) as a function of radius (real number <math>\geq 0</math>) (m).</p>
<b>NCHANNEL nchannel</b>	<p>: OPTIONAL keyword, followed by an integer <math>\geq 0</math>, defining the number of identical FUELPLAQ in the axial element elem.  <b>The default setting</b> is a single FUELPLAQ and channel = 1. To represent a <b>theoretical</b> rod, i.e. a rod not acting on hydraulic conditions, nchannel must be 0.</p>

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 231/851</a>

**AXICOND** : [HTR](#) application only - OPTIONAL keyword  
 It indicates that axial conduction within FUELPLAQ will be computed.  
 To enable the axial conduction, AXICOND directive has to be declared in the command block.

<b>SEGMENT</b>	: keyword indicating that a segment is to be read and upon which a FUELPLAQ wall is to be defined. This is followed by :	<b>To be repeated as many times as number of segments</b>
<b>Pi Pj</b>	: pair of vector points which must belong to the mesh of the axial element and which defines the start and the end of the segment. These two points must be given in the order in which the hydraulic meshing is defined.	

<b>material1</b>	: imposed keyword defining the nature of the used material, to select in the following list :	<b>To be repeated as many times as number of materials</b>	<b>To be repeated as many times as number of segments</b>
MGO TOPHET <sup>1</sup> NITRBORE ACIER533 ACIER508 INOXVES <sup>2</sup> INOX304 INOX316 INOX347 INCON600 INCON690 INCON718 INCON800 INCON625 LOB14948 CERAMIC NI201 LOB14571 GAP ZIRCALOY AL2O3 XXXXXXi	Magnesium oxide Tophet A (Nichrome 5) Boron nitride Steel SA533 grade B A508 carbon steel Stainless steel 304 stainless steel 316 stainless steel 347 stainless steel Inconel 600 Inconel 690 Inconel 718 Inconel 800 Inconel 625 1.4948 (Lobi Loop) Ceramic (Al <sub>2</sub> O <sub>3</sub> ) Ni 201 1.4571 (Lobi Loop) 100% Helium zircaloy Al <sub>2</sub> O <sub>3</sub> (Alumin for REBEKA) (i=1,6) user defined material name (FWMAXX subroutine to be defined in the range 28 to 33 ) Name given to a material defined with the MATERIAL operator		
	<b>N.B.2 :</b> Materials will be given with respect to wall radial mesh definition.		

<b>* Radial mesh</b>	The radial mesh data will be given in increasing order (m). ⇒ Two possibilities to enter the radial mesh of the FUELPLAQ wall	<b>To be repeated as many times as number of materials</b>	<b>To be repeated as many times as number of segments</b>
----------------------	--	--	---

<sup>1</sup>Beware that CATHARE<sub>p</sub> x Cp values have been found to be strongly underestimated

<sup>2</sup>Beware that CATHARE<sub>p</sub> x Cp values have been found to be false (<0.) above 890°C

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 232/851

<p><b>1) DATA nm1</b></p> <p><b>DIAM d1 d2 ...dnm1+ 1:</b></p> <p>or</p> <p><b>THICK d1 d2 ...dnm1+ 1</b></p> <p>or</p> <p><b>DINI d11 d21 ...dnm11+1</b></p> <p>or</p> <p><b>THINI d11 d21 ...dnm11+1</b></p> <p>or</p> <p><b>DEND d12 d22 ...dnm12+1</b></p> <p>or</p> <p><b>THEND d12 d22 ...dnm12+1</b></p> <p><b>2) ISO nm1</b></p>	<p>: keyword indicating that the radial mesh will be defined <u>mesh by mesh</u> by the user. This is followed by an integer <math>&gt; 0</math> defining the number of meshes in the thickness of the wall. nm1 must be the same for all segments of a wall.</p> <p>Two possibilities:</p> <p>a) The diameters or thicknesses are <u>constant</u> along the segment:</p> <p>keyword indicating that the diameters are constant all along the segment. This is followed by nm1+1 real numbers <math>&gt; 0</math>. defining the diameters of each radial mesh.</p> <p>(case of a PLANE FUELPLAQ wall): keyword indicating that the thicknesses are constant all along the segment. This is followed by nm1+1 real numbers <math>&gt; 0</math>. defining the thickness of each radial mesh:</p> <p>The first value (d1) has no real meaning , it is a reference value; <math>d2 = d1 + \text{thickness\_radial\_mesh\_cell1}</math>, etc...</p> <p>b) The diameters or thicknesses vary linearly along the segment. The diameters or thicknesses at the start and at the end of the segment are then given. Diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by <u>linear interpolation</u> between the values given at the start and end of the segment.</p> <p>: keyword followed by nm1+1 real numbers <math>&gt; 0</math>. defining diameters at the start of the segment.</p> <p>(case of a PLANE FUELPLAQ wall): keyword followed by nm1+1 real numbers <math>&gt; 0</math>. defining the thicknesses at the start of the segment.</p> <p>The first value (d11) has no real meaning ; <math>d21 = d11 + \text{thickness\_radial\_mesh\_cell1}</math>, etc...</p> <p>: keyword followed by nm1+1 real numbers <math>&gt; 0</math>. defining the diameters at the end of the segment.</p> <p>(case of a PLANE FUELPLAQ wall): keyword followed by nm1+1 real numbers <math>&gt; 0</math>. defining the thicknesses at the end of the segment.</p> <p>The first value (d12) has no real meaning ; <math>d22 = d12 + \text{thickness\_radial\_mesh\_cell1}</math>, etc...</p> <p><b>Warning :</b> In the present version, nm1 must be the same for all segments of a single FUELPLAQ wall.</p> <p>: keyword indicating that the radial mesh is defined as <u>isovolume</u>. This is followed by an integer <math>&gt; 0</math> defining the number of meshes in the thickness of the FUELPLAQ wall.</p> <p>Two possibilities :</p> <p>a) The diameters or thicknesses are <u>constant</u> along the segment :</p>	<p>To be re-peated as many times as number of segments</p> <p>To be re-peated as many times as number of materials</p>
--	--	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 233/851

<b>DIAM</b> <b>di dext</b>  or <b>THICK</b> <b>di dext</b>  or <b>DINI</b> <b>di1 dext1</b> or <b>THINI</b> <b>di1 dext1</b>  <b>DEND</b> <b>di2 dext2</b> or <b>THEND</b> <b>di2 dext2</b>	<p>: keyword indicating that diameters are constant all along the segment. This is followed by two real numbers <math>&gt; 0</math> defining the internal and external diameters of the wall.</p> <p>(case of a PLANE FUELPLAQ wall) : keyword indicating that thicknesses are constant all along the segment. This is followed by two real numbers <math>&gt; 0</math>.          The first value is a reference value and the second one the first value added to the thickness of the FUELPLAQ wall.</p> <p>b) The diameters or thicknesses vary linearly along the segment. The diameters at the start and at the end of the segment are then given.          The diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by <u>linear interpolation</u> between the values given at the start and end of the segment.</p> <p>: keyword followed by two real numbers <math>&gt; 0</math>. defining the internal and external diameters at the start of the segment.</p> <p>(case of a PLANE FUELPLAQ wall) : keyword followed by two real numbers <math>&gt; 0</math>.          The first value is a reference value and the second one the first value added to the thickness of the wall at the start of the segment.</p> <p>: keyword followed by two two real numbers <math>&gt; 0</math>. defining the internal and external diameters at the end of the segment.</p> <p>(case of a PLANE FUELPLAQ wall) : keyword followed by two real numbers <math>&gt; 0</math>.          The first value is a reference value and the second one the first value added to the thickness of the wall at the end of the segment.  <u>Warning</u> : In the present version, nm1 must be the same for all segments of a single FUELPLAQ wall.</p>
---	---

#### **\*Free fuel (FNR only)**

<b>FREE</b>  <b>nray</b>  <b>listfree</b>	<p>OPTIONAL keyword to indicate that a free fuel is taken into account in the calculation of the anti-reactivity coefficient resulting from the fuel axial thermal expansion. So the coefficient is function of the temperature in a given radial mesh of the fuel layer (or the average temperature in the fuel layer) and not a function of the fluid temperature variations (as it is when fuel is in contact with the cladding).</p> <p>nray is an integer value, defining the radial mesh number of the wall chosen. If nray=0, then the average temperature of the fuel is taken.</p> <p><b>NB :</b> the FREE option is taken into account all along the SEGMENT.</p> <p>OPTIONAL realist object (see REALIST directive) defining for each axial mesh of the FUELPLAQ wether the FREE option is used (1) or not (0)</p>
---	---

**To be  
repeated  
as many  
times as  
number  
of  
segments**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 234/851

**Warning:** the FREE option should be consistent with the CO-EFKFA and AZKFUEA coefficients  
if the FREE option is chosen on several segments, nray should be the same for all the segments.

#### \* Contact resistance

To simulate contact resistance between two materials of a given WALL. It can be located only at a specified material change radial location

**Warning:** only one such conduction specific feature is allowed in the radial direction of each elementary wall.

#### **RESIST**

OPTIONAL keyword to indicate that a contact resistance is going to be modeled

#### **VALUE Hres or resist**

Hres : value of the heat transfer resistance coefficient (W/m<sup>2</sup>/K).  
resist : realist object (see **REALIST** directive) defining the heat transfer resistance coefficient (W/m<sup>2</sup>/K) on each axial mesh of the segment.

#### **MODEL YYYYYYij**

means that the value of the heat transfer resistance coefficient is calculated by the code from the user's material "YYYYYYij". In that case, the heat transfer resistance coefficient can be correlated with the heat flux intensity through the contact resistance.

#### **HEATFLUX or TEMP**

OPTIONAL keyword to indicate that the heat transfer resistance coefficient calculated in the user's material "YYYYYYij" depends either on the heat flux intensity crossing the contact resistance or on the local temperature. Default value is HEATFLUX.

#### **RIGHT**

Means that the contact resistance is spread on the first mesh of the next radial material

#### **LEFT**

Means that the contact resistance is spread on the last mesh of the previous radial material

#### **MEDIUM miq1**

: keyword to be used for **PWR** application only. It is followed by an integer > 0 defining the index of the heating medium type. For example, if there are two materials constituting the FUELPLAQ wall, miq1 can be equal to 1 or 2.

**To be  
repeated  
as many  
times as  
number  
of  
segments**

#### \*HTR and FNR applications only

#### **DOPPLER dop1**

: OPTIONAL keyword. It is followed by an integer > 0 defining the index of the heating medium type.

#### **FRACNEU fracneu1**

: keyword followed by a real > 0 defining the distribution coefficient of the neutronic power fraction (defined by COEFKNEU) in the Doppler medium dop1. The sum of the FRACNEU radial coefficients per segment should be equal to 1.

#### **FRACRES fracres1**

: keyword followed by a real > 0 defining the distribution of the residual power fraction (defined by COEFKRES) in the Doppler medium dop1. The sum of the FRACRES radial coefficients per segment should be equal to 1.

#### **MODERAT mod2**

: **HTR** application only - OPTIONAL keyword. It is followed by an integer > 0 defining the index of the moderate medium type.

#### **MODERAT mod1**

: **HTR** application only - OPTIONAL keyword. It is followed by an integer > 0 defining the index of the moderate medium type.

**To be  
repeated  
as many  
times as  
number  
of  
segments**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 235/851

<b>FRACNEU</b> <b>fracneu2</b>	: keyword followed by a real $> 0$ defining the neutronic power coefficient for the segment, that is the neutronic power fraction received by the segment (in the Moderate medium) with respect to the FUELPLAQ received neutronic power.
<b>REFLECT</b> <b>refl1</b>	: OPTIONAL keyword. It is followed by an integer $> 0$ defining the index of the reflector medium type.
<b>FRACNEU</b> <b>fracneu3</b>	: keyword followed by a real $> 0$ defining the neutronic power coefficient for the segment, that is the neutronic power fraction received by the segment (in the Reflector medium) with respect to the FUELPLAQ received neutronic power.
<b>FRACKR</b> <b>frackr1</b>	: <b>HTR</b> application only. Keyword followed by a real $> 0$ defining the reflector coefficient for the segment.
<b>HEXDUCT</b> <b>hex1</b>	: <b>FNR</b> application only - OPTIONAL keyword. It is followed by an integer $> 0$ defining the index of the duct medium type.
<b>CONTPAD :</b> <b>FRACNEU</b> <b>fracneu4</b>	keyword indicating the position of the contact pad : keyword followed by a real $> 0$ defining the neutronic power coefficient for the segment, that is the neutronic power fraction received by the segment (in the duct medium) with respect to the FUELPLAQ received neutronic power.

#### **\*Heating perimeter**

<b>HPERIM</b>	: keyword indicating that the heating perimeter is to be given. <b>Warning</b> : Generally, the heating perimeter is equal to the geometrical perimeter. Using a multiple of the geometrical perimeter is intended to serve as a weight factor. ⇒ Two possibilities to enter the heating perimeter :
<b>1) POINT</b>	The heating perimeters for all the axial meshes located between the two vector points on which the heating perimeter was given will be calculated by <u>linear interpolation</u> between the values of these two points.
<b>Ip</b> or <b>Ip1 AND Ip2</b> <b>AND</b> ... <b>Ipn</b> <b>perip</b>	: if the heating perimeter is given on certain vector points of the segment. In this case the vector points used hereafter must be included in the list of vector points already defined. This keyword is followed by as many Pp perip groups as necessary with : : vector point belonging to the axial mesh of the segment.  : All the vector points between Ip1, Ip2 and Ipn have the same heating perimeter and belong necessarily to the axial mesh of the segment.  : real number $> 0$ . defining the heating perimeter (m) on these points.
<b>2) CONST</b> <b>peri</b> <b>MULTH</b>	The heating perimeters is constant all along the segment. : keyword followed by a real number $> 0$ . defining the heating perimeter (m). : OPTIONAL keyword used to modify the standard heat exchange correlation. This is to account for heat exchange devices such as fins ; such devices cannot be properly simulated by a modification of the heating perimeter. This keyword is followed by :

**To be  
repeated  
as many  
times as  
number  
of  
segments**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 236/851

<b>xhint</b> <b>xhext</b>  <b>PROFILE</b> <b>ENRICH</b>  <b>enr1</b> <b>enr_list</b> <b>TAUREMP</b>  <b>tauremp1</b> <b>tauremp_list</b>  <b>ZKPOWNR</b>  <b>puis1</b>  <b>list1</b>  <b>PINI puisini</b> <b>PEND puisend</b>  <b>ZKPOWRS</b>	<p>: value of the multiplicative coefficient for the inner side of the wall</p> <p>: value of the multiplicative coefficient for the outside of the wall</p> <p>: keyword indicating that the power, anti-reactivity and Doppler effect linear profiles will be given. This keyword is followed by:</p> <p>: OPTIONAL keyword indicating that the fuel Pu enrichment profile will be given. This keyword is only available for <b>FNR</b> application. If this profile is <u>constant</u> along the segment, a constant value is given: : real number <math>&gt; 0</math> and <math>&lt; 1</math> defining a constant fuel Pu enrichment profile. Whatever real number is given, the constant profile is equal to 0 everywhere. The profile can be given on <u>each axial mesh</u> of the segment: : realist object (see REALLIST directive) defining the fuel Pu enrichment profile value on each axial mesh of the segment.</p> <p>: OPTIONAL keyword indicating that the pellet compaction rate profile will be given. This keyword is only available for <b>FNR</b> application. If this profile is <u>constant</u> along the segment, a constant value is given: : real number <math>&gt; 0</math> and <math>&lt; 1</math> defining a constant pellet compaction rate profile. Whatever real number is given, the constant profile is equal to 0 everywhere. The profile can be given on <u>each axial mesh</u> of the segment. : realist object (see REALLIST directive) defining the pellet compaction rate profile value on each axial mesh of the segment.</p> <p>: keyword indicating that non residual power profile will be given. This keyword is available for both <b>HTR</b> and <b>PWR</b> application. If this profile is <u>constant</u> along the segment, a constant value is given: : real number <math>&gt; 0</math> defining a constant non residual power profile. Whatever real number is given, the constant profile is equal to 1 everywhere. The profile can be given on <u>each axial mesh</u> of the segment: : realist object (see REALLIST directive) defining the non residual power profile value on each axial mesh of the segment.</p> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment. : keyword followed by a real number <math>&gt; 0</math>. defining the non residual power profile at the start of the segment (vector point). : keyword followed by a real number <math>&gt; 0</math>. defining the non residual power profile at the end of the segment (vector point).</p> <p>: keyword indicating that the residual power profile will be given. This keyword is available for both <b>HTR</b> and <b>PWR</b> application N.B: For a <b>HTR</b> application, this is an OPTIONAL keyword depending of the medium type chosen on the segment. If this profile is <u>constant</u> along the segment, a constant value is given:</p>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
		<b>To be repeated as many times as number of segments</b>

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 237/851</a>

<b>puis2</b>  <b>list2</b>  <b>PINI puisini</b>  <b>PEND puisend</b>	<p>: real number &gt; 0 defining a constant residual power profile. Whatever real number is given, the constant profile is equal to 1 everywhere. The profile can be given on <u>each axial mesh</u> of the segment:</p> <p>: realist object (see REALIST directive) defining the residual power profile value on each axial mesh of the segment. The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment:</p> <p>: keyword followed by a real number &gt; 0. defining the residual power profile at the start of the segment (vector point). : keyword followed by a real number &gt; 0. defining the residual power profile at the end of the segment (vector point).</p>	
<b>AZKMOD</b>  <b>az3</b>  <b>list3</b>	<p>: keyword indicating that the profile for the anti-reactivity resulting from moderator density (<b>PWR application</b>) or moderator temperature (<b>HTR application</b>) variations will be given. This keyword is available for both <b>PWR</b> and <b>HTR</b> application. <b>N.B:</b> For a <b>HTR</b> application, this is an OPTIONAL keyword depending of the medium type chosen on the segment. If this profile is <u>constant</u> along the segment, a constant value is given:</p> <p>: real number &gt; 0. defining a constant profile for the anti-reactivity resulting from moderator density variations. Whatever real number is given, the constant profile is equal to 1 everywhere. The profile can be given on <u>each axial mesh</u> of the segment:</p> <p>: realist object (see REALIST directive) defining the profile value, for the anti-reactivity resulting from moderator density variations on each axial mesh of :</p> <ul style="list-style-type: none"> <li>• the FUELPLAQ wall, if ABSMESH keyword is used</li> <li>• the segment, if ABSMESH keyword is not used</li> </ul>	<p><b>To be repeated as many times as number of segments</b></p>
<b>AZINI azini</b>  <b>AZEND azend</b>  <b>AZKDOP</b>	<p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p> <p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the start of the segment (vector point). : keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from moderator density variations, at the end of the segment (vector point).</p> <p>: keyword indicating that the profile for the anti-reactivity resulting from the Doppler effect will be given. This keyword is available for all applications. If this profile is <u>constant</u> along the segment, a constant value is given:</p> <p>: real number &gt; 0. defining a constant profile for the anti-reactivity resulting from the Doppler effect. Whatever real number is given, the constant profile is equal to 1 everywhere. The profile can be given on <u>each axial mesh</u> of the segment:</p>	
<b>az4</b>		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 238/851

**list4**

: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the Doppler effect, on each axial mesh of :

- the FUELPLAQ wall, if ABSMESH keyword is used
- the segment, if ABSMESH keyword is not used

The profile can be calculated by linear interpolation between the profile values given at the start and end of the segment:

**AZINI azini**

: keyword followed by a real number > 0. defining the profile value, for the anti-reactivity resulting from the Doppler effect, at the start of the segment (vector point).

**AZEND azend**

: keyword followed by a real number > 0. defining the profile value, for the anti-reactivity resulting from the Doppler effect, at the end of the segment (vector point).

**AZKFUER  
AZKFUEA**

: keyword indicating that the profile for the anti-reactivity resulting from the fuel radial / axial thermal expansion will be given. This keyword is available for all applications.

If this profile is constant along the segment, a constant value is given:

**az7 / az8**

: real number > 0. defining a constant profile for the anti-reactivity resulting from fuel radial / axial thermal expansion. Whatever real number is given, the constant profile is equal to 1 everywhere.

The profile can be given on each axial mesh of the segment.

**list7 / list 8**

: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from fuel radial / axial thermal expansion, on each axial mesh of :

- the FUELPLAQ wall, if ABSMESH keyword is used
- the segment, if ABSMESH keyword is not used

The profile can be calculated by linear interpolation between the profile values given at the start and end of the segment.

**AZINI azini**

: keyword followed by a real number > 0. defining the profile value, for the anti-reactivity resulting from fuel radial / axial thermal expansion, at the start of the segment (vector point).

**AZEND azend**

: keyword followed by a real number > 0. defining the profile value, for the anti-reactivity resulting from fuel radial / axial thermal expansion, at the end of the segment (vector point).

**AZKREF**

: keyword indicating that the profile for the anti-reactivity resulting from the reflector temperature variations will be given. This keyword is available for **HTR** application only.

If this profile is constant along the segment, a constant value is given:

**az5**

: real number > 0. defining a constant profile for the anti-reactivity resulting from the reflector effect. Whatever real number is given, the constant profile is equal to 1. everywhere.

The profile can be given on each axial mesh of the segment.

**To be  
repeated  
as many  
times as  
number  
of  
segments**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 239/851

<b>list 5</b> <b>AZINI azini</b> <b>AZEND azend</b>  <b>AZKVOID</b> <b>az6</b>  <b>list6</b> <b>AZINI azini</b> <b>AZEND azend</b>  <b>AZKCLAR</b> <b>AZKCLAA</b>  <b>az9 / az10</b>	<p>: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the reflector effect, on each axial mesh of :</p> <ul style="list-style-type: none"> <li>• the FUELPLAQ wall, if ABSMESH keyword is used</li> <li>• the segment, if ABSMESH keyword is not used</li> </ul> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p> <p><b>AZINI azini</b> : keyword followed by a real number <math>&gt; 0</math> defining the profile value, for the anti-reactivity resulting from the reflector effect, at the start of the segment (vector point).</p> <p><b>AZEND azend</b> : keyword followed by a real number <math>&gt; 0</math> defining the profile value, for the anti-reactivity resulting from the reflector effect, at the end of the segment (vector point).</p> <p><b>AZKVOID</b> : keyword indicating that the profile for the anti-reactivity resulting from FLUID density (<i>so called “Void effect”</i>) variations will be given. This keyword is available for <b>HTR</b> and <b>FNR</b> applications only.</p> <p>If this profile is <u>constant</u> along the segment, a constant value is given:</p> <p><b>az6</b> : real number <math>&gt; 0</math>. defining a constant profile for the anti-reactivity resulting from fluid density variations. Whatever real number is given, the constant profile is equal to 1 everywhere.</p> <p>The profile can be given on <u>each axial mesh</u> of the segment.</p> <p><b>list6</b> : realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the fluid density variations, on each axial mesh of :</p> <ul style="list-style-type: none"> <li>• the FUELPLAQ wall, if ABSMESH keyword is used</li> <li>• the segment, if ABSMESH keyword is not used</li> </ul> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p> <p><b>AZINI azini</b> : keyword followed by a real number <math>&gt; 0</math>. defining the profile value, for the anti-reactivity resulting from the fluid density variations, at the start of the segment (vector point).</p> <p><b>AZEND azend</b> : keyword followed by a real number <math>&gt; 0</math>. defining the profile value, for the anti-reactivity resulting from the fluid density variations, at the end of the segment (vector point).</p> <p><b>AZKCLAR</b> : keyword indicating that the profile for the anti-reactivity from cladding radial / axial thermal expansion will be given. This keyword is available for all applications.</p> <p>If this profile is <u>constant</u> along the segment, a constant value is given:</p> <p><b>AZKCLAA</b> : real number <math>&gt; 0</math>. defining a constant profile for the anti-reactivity resulting from the cladding radial / axial thermal expansion. Whatever real number is given, the constant profile is equal to 1 everywhere.</p> <p><b>az9 / az10</b> The profile can be given on <u>each axial mesh</u> of the segment.</p>	<i>To be repeated as many times as number of segments</i>
--	--	---

		<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i></p>
<b>Document technique DEN</b>		Page 240/851

<b>list9 / list10</b>	<p>: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the cladding radial / axial thermal expansion, on each axial mesh of :</p> <ul style="list-style-type: none"> <li>• the FUELPLAQ wall, if ABSMESH keyword is used</li> <li>• the segment, if ABSMESH keyword is not used</li> </ul> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p>
<b>AZINI azini</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from the cladding radial / axial thermal expansion, at the start of the segment (vector point).</p>
<b>AZEND azend</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from the cladding radial / axial thermal expansion, at the end of the segment (vector point).</p>
<b>AZKDUCR / AZKDUCA</b>	<p>: keyword indicating that the profile for the anti-reactivity resulting from the duct radial / axial thermal expansion will be given. This keyword is available for all applications.</p> <p>If this profile is <u>constant</u> along the segment, a constant value is given:</p>
<b>az11 / az12</b>	<p>: real number &gt; 0. defining a constant profile for the anti-reactivity resulting from the duct radial / axial thermal expansion. Whatever real number is given, the constant profile is equal to 1 everywhere.</p> <p>The profile can be given on <u>each axial mesh</u> of the segment.</p>
<b>list11 / list12</b>	<p>: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the duct radial / axial thermal expansion, on each axial mesh of :</p> <ul style="list-style-type: none"> <li>• the FUELPLAQ wall, if ABSMESH keyword is used</li> <li>• the segment, if ABSMESH keyword is not used</li> </ul> <p>The profile can be calculated <u>by linear interpolation</u> between the profile values given at the start and end of the segment.</p>
<b>AZINI azini</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from the duct radial / axial thermal expansion, at the start of the segment (vector point).</p>
<b>AZEND azend</b>	<p>: keyword followed by a real number &gt; 0. defining the profile value, for the anti-reactivity resulting from the duct radial / axial thermal expansion, at the end of the segment (vector point).</p>
<b>AZKBOR</b>	<p>: OPTIONAL keyword indicating that the profile for the anti-reactivity resulting from the boron effect will be given. This keyword has to be used only when the integration method ( <b>CO-EFKB</b> keyword) has been chosen</p> <p>If this profile is <u>constant</u> along the segment, a constant value is given:</p>
<b>az5</b>	<p>: real number &gt; 0. defining a constant profile for the anti-reactivity resulting from the boron effect. Whatever real number is given, the constant profile is equal to 1. everywhere.</p> <p>The profile can be given on <u>each axial mesh</u> of the segment.</p>

**To be  
repeated  
as many  
times as  
number  
of  
segments**

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 241/851

**list 5**

: realist object (see REALLIST directive) defining the profile value, for the anti-reactivity resulting from the boron effect, on each axial mesh of :

- the FUELPLAQ wall, if ABSMESH keyword is used
- the segment, if ABSMESH keyword is not used

The profile can be calculated by linear interpolation between the profile values given at the start and end of the segment.

**AZINI azini**

: keyword followed by a real number  $> 0$  defining the profile value, for the anti-reactivity resulting from the boron effect, at the start of the segment (vector point).

**AZEND azend**

: keyword followed by a real number  $> 0$  defining the profile value, for the anti-reactivity resulting from the boron effect, at the end of the segment (vector point).

**\*Case of an exchange with the outside environment**
**LOSS**

: OPTIONAL keyword, to take into account heat exchange with the outside. By default there is no exchange.

**RADEXT**

: OPTIONAL keyword, to define this exchange with the outside as a radiative one. By default there is no radiative exchange.

⇒ Three possibilities to define the exchange with the outside environment :

**Warning:** Radiative exchange (case A) may be combined with the conductive exchange (case B or C)

**A : Case where the exchange is defined by a non-dimensional surface emissivity and an outside temperature**

⇒ Two possibilities to define the non-dimensional surface emissivity exchange coefficient :

**1)** Case where the non-dimensional surface emissivity used for radiation heat transfer coefficient is constant or is given for each of the axial meshes of the segment. Then the following keywords are to be used :

: keyword indicating that the non-dimensional surface emissivity used for radiation heat transfer is to be given.

If the non-dimensional surface emissivity used for radiation heat transfer is constant on all the axial meshes of the segment:

**EEXT**

: real number  $\geq 0$ . and  $\leq 1$ . representing the non-dimensional surface emissivity used for radiation heat transfer.

or

**liste1**

: realist object (see REALLIST directive) defining the value of the non-dimensional surface emissivity used for radiation heat transfer on each of the axial meshes of the segment.

To be  
repeated  
as many  
times as  
number  
of  
segments

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 242/851</a>

**2)** Case where the non-dimensional surface emissivity used for radiation heat transfer is calculated by linear interpolation between the non-dimensional surface emissivities defined at the start and the end of segment :

: keyword followed by a real number  $\geq 0.$  and  $\leq 1.$  defining the non-dimensional surface emissivity used for radiation heat transfer at the start of the segment.

: keyword followed by a real number  $\geq 0.$  and  $\leq 1.$  defining the non-dimensional surface emissivity used for radiation heat transfer at the end of the segment.

⇒ Two possibilities to define the outside temperature

**1)** Case where the outside temperature is constant or is given for each of the axial meshes of the segment. The following keywords are used:

: keyword indicating that the outside temperature is to be given.  
If the outside temperature is constant on all the axial meshes of the segment:

: real number  $> -273.$  defining the outside temperature ( $^{\circ}\text{C}$ ).

If the outside temperature is not constant on the axial meshes of the segment :

: realist object (see REALLIST directive) defining the value of the temperature on each of the axial meshes of the segment ( $^{\circ}\text{C}$ ).

**2)** Case where the outside temperature is calculated by linear interpolation between the outside temperature at the start and end of the segment.

: keyword followed by a real number  $> -273.0$  ( $^{\circ}\text{C}$ ) defining the outside temperature at the start of the segment.

: keyword followed by a real number  $> -273.0$  ( $^{\circ}\text{C}$ ) defining the outside temperature at the end of the segment.

#### **B) Case where the exchange is defined by a convective exchange coefficient and an outside temperature**

⇒ Two possibilities to define the convective exchange coefficient:

**1)** Case where the convective exchange coefficient is constant or is given for each of the axial meshes of the segment. Then the following keywords are :

: keyword indicating that the convective exchange coefficient is to be given.  
If the convective exchange coefficient is constant on all the axial meshes of the segment:

: real number  $> 0.$  defining the convective exchange coefficient ( $\text{W/m}^2/\text{^{\circ}C}$ ).

If the convective exchange coefficient is not constant on the axial meshes of the segment:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 243/851

**list1**

: realist object (see REALIST directive) defining the value of the convective exchange coefficient ( $\text{W}/\text{m}^2/\text{°C}$ ) on each of the axial meshes of the segment.

**2)** Case where the convective exchange coefficient is calculated by linear interpolation between the convective exchange coefficients at the start and end of segment :

: keyword followed by a real number  $> 0$ . defining the convective exchange coefficient at the start of the segment ( $\text{W}/\text{m}^2/\text{°C}$ ).

: keyword followed by a real number  $> 0$ . defining the convective exchange coefficient at the end of the segment ( $\text{W}/\text{m}^2/\text{°C}$ ).

⇒ Two possibilities to define the outside temperature :

**1)** Case where the outside temperature is constant or is given for each of the axial meshes of the segment. Then the following keywords are:

: keyword indicating that the outside temperature is to be given. If the outside temperature is constant on all the axial meshes of the segment:

: real number  $> -273$ . defining the outside temperature ( $\text{°C}$ ).

**TEXT****text1**  
or

if the outside temperature is not constant on the axial meshes of the segment :

: realist object (see REALIST directive) defining the value of the temperature on each of the axial meshes of the segment ( $\text{°C}$ ).

**2)** Case where the outside temperature is calculated by linear interpolation between the outside temperature at the start and end of the segment.

: keyword followed by a real number  $> -273.0$  ( $\text{°C}$ ) defining the outside temperature at the start of the segment.

: keyword followed by a real number  $> -273.0$  ( $\text{°C}$ ) defining the outside temperature at the end of the segment.

**C) Case where the exchange is defined by an exchange flux with the outside environment :**

⇒ Two possibilities to define the exchange flux:

**1)** Case where the exchange flux is constant or is given for each of the axial meshes of the segment. Then the followind keywords are:

: keyword indicating that the exchange flux is to be given.

If the exchange flux is constant over the entire axial mesh:

: real number defining the exchange flux ( $\text{W}/\text{m}^2$ ). The flux is lost by the wall if ( $\varphi_{ext} < 0$ ) and received if ( $\varphi_{ext} > 0$ ). Its expression is :  $\varphi_{ext} = -h \cdot (T_w - T_{ext})$ .

**PHIEXT****phiext1**

or

if the exchange flux is not constant on the axial meshes of the segment

**to be  
re-  
peated  
as  
many  
times  
as  
there  
are  
num-  
ber of  
seg-  
ments**

		<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
	<b>Document technique DEN</b>	Page 244/851

**list1**

: realist object (see REALIST directive) defining the value of the exchange flux ( $\text{W/m}^2$ ) on each of the axial meshes of the segment.

**2)** Case where the exchange flux is calculated by linear interpolation between the exchange flux at the start and end of the segment :

: keyword followed by a real number defining the exchange flux ( $\text{W/m}^2$ ) (positive or negative) at start of the segment.

: keyword followed by a real number defining the exchange flux ( $\text{W/m}^2$ ) (positive or negative) at the end of the segment.

**PHIINI phiini**

**PHIEND phifin**

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 245/851

**Example**

**PWR applications**

**1)**

```

plaql = FUELPLAQ downco EXTERNAL CYLINDER
         COEFKNEU 1.0    COEFKRES 0.62
         COEFKM   6.62D-2 COEFKD   0.3015D0
         COEFKB   DENSITY 1.0D0    0.5D0     0.97D0
         XNEUT    0.974D0 LAW      LOIRAD
         SEGMENT   p3      p6
         YYYYYY01  DATA 2  DIAM    3.988    4.088    4.478
         HPERIM   CONST   12.529
         MEDIUM   1
         PROFILE  ZKPOWNR 1.0
                  ZKPOWRS 1.0
                  AZKMOD  1.0
                  AZKDOP  1.0
                  AZKBOR  1.0 ;
  
```

with

LOIRAD =	LAW	'RADIUS'	'POWER'		
		0.D0	0.93504D0		
		1.832D-3	0.95497D0		
		2.591D-3	0.98539D0		
		3.173D-3	1.01308D0		
		3.664D-3	1.04059D0		
		4.096D-3	1.06135D0		
					;

**2)**

```

plaql = FUELPLAQ coeurmoy INTERNAL CYLINDER
         COEFKNEU 1.0    COEFKRES 0.62    COEFKM   6.62D-2
         COEFKD   0.3015D0 XNEUT   0.974D0 LAW      law1
         SEGMENT   P8      P11
         MGO      ISO      1          DIAM    0.          1.d-3
         TPHET    ISO      1          DIAM    1.d-3     2.4d-3
         RESIST   VALUE   1.0D+2   RIGHT
         MGO      ISO      1          DIAM    2.4d-3    8.36d-3
         INCON800 ISO      2          DIAM    8.36d-3    9.5d-3
         HPERIM   CONST   2.9845d-2
         MEDIUM   2
         PROFILE  ZKPOWNR 1.0
                  ZKPOWRS 1.0
                  AZKMOD  1.0
                  AZKDOP  1.0 ;
  
```

with

law1=LAW	'RADIUS'	'POWER'		
	0.	1.		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 246/851</a>

100. 1. ;

3)

plaq3 =	FUELPLAQ	coeurmoy	INTERNAL	PLANE	
COEFKNEU	1.0	COEFKRES	0.62	COEFKM	6.62D-2
COEFKD	0.3015D0	XNEUT	0.974D0	LAW	LOIRAD
SEGMENT	P15	P18			
XXXXXXX1	ISO	5	THICK	0.D0	4.096D-3
XXXXXXX2	ISO	4	THICK	4.096D-3	4.749D-3
MEDIUM	1				
HPERIM	CONST	2.983884D-2			
PROFILE	ZKPOWNR	zkpownr1			
	ZKPOWRS	zkpowrs1			
	AZKMOD	azkmod1			
	AZKDOP	azkdop1 ;			

with

LOIRAD =	LAW	'RADIUS'	'POWER'	
		0.D0	0.93504D0	
		1.832D-3	0.95497D0	
		2.591D-3	0.98539D0	
		3.173D-3	1.01308D0	
		3.664D-3	1.04059D0	
		4.096D-3	1.06135D0 ;	

zkpownr1 =	REALLIST			
0.348399730	0.563333278	0.7335760	0.80598443	
0.8257296	0.849449475	0.899618351	0.995291830	
1.149684421	1.306339834	1.38988136	1.3924397	
1.289542045	1.187984382	1.087977430	1.06390718 ;	

zkpowrs1 =	REALLIST			
0.348399730	0.563333278	0.7335760	0.80598443	
0.8257296	0.849449475	0.899618351	0.995291830	
1.149684421	1.306339834	1.38988136	1.3924397	
1.289542045	1.187984382	1.087977430	1.06390718 ;	

azkmod1 =	REALLIST			
0.348399730	0.563333278	0.7335760	0.80598443	
0.8257296	0.849449475	0.899618351	0.995291830	
1.149684421	1.306339834	1.38988136	1.3924397	
1.289542045	1.187984382	1.087977430	1.06390718 ;	

azkdop1 =	REALLIST			
0.112570534	0.297267967	0.501773377	0.60292855	
0.6323506	0.669238125	0.750723721	0.918822174	
1.226233414	1.583929803	1.79160633	1.7981501	
1.543770881	1.318631334	1.101896256	1.04973122 ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 247/851

4)

plaq4 =	FUELPLAQ	steamgen	INTERNAL	CYLINDER	
COEFKNEU	1.0	COEFKRES	0.62	COEFKM	6.62D-2
COEFKD	0.3015D0	XNEUT	0.974D0	LAW	LOIRAD
SEGMENT	P12	P16			
YYYYYYY01	DATA 2	DIAM	.7366	.7766	.8656
HPERIM	POINT	(p12	AND	p16)	
		2.3141			
MEDIUM	1				
PROFILE	ZKPOWNR	1.0			
	ZKPOWRS	1.0			
	AZKMOD	1.0			
	AZKDOP	1.0			
SEGMENT	P16	P17			
YYYYYYY01	DATA 2	DINI	.7366	.7766	.8656
		DEND	3.1466	3.2	3.25
HPERIM	POINT	p16	2.3141	p17	8.065
MEDIUM	1				
PROFILE	ZKPOWNR	1.0			
	ZKPOWRS	1.0			
	AZKMOD	1.0			
	AZKDOP	1.0			
SEGMENT	P17	P18			
YYYYYYY01	DATA 2	DIAM	3.1466	3.2	3.25
HPERIM	POINT	p17	8.065	p18	107.
MEDIUM	1				
PROFILE	ZKPOWNR	1.0			
	ZKPOWRS	1.0			
	AZKMOD	1.0			
	AZKDOP	1.0			
SEGMENT	P18	P19			
YYYYYYY01	DATA 2	DIAM	.01968	.034	.04884
HPERIM	POINT	p18	107.	p19	205.935
MEDIUM	1				
PROFILE	ZKPOWNR	1.0			
	ZKPOWRS	1.0			
	AZKMOD	1.0			
	AZKDOP	1.0 ;			

with

LOIRAD =	LAW	'RADIUS'	'POWER'	
		0.D0	0.93504D0	
		1.832D-3	0.95497D0	
		2.591D-3	0.98539D0	
		3.173D-3	1.01308D0	
		3.664D-3	1.04059D0	
		4.096D-3	1.06135D0 ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 248/851

### HTR application

1)

plaql =	FUELPLAQ	axac	HTR	EXTERNAL	CYLINDER
	COEFKNEU	1.0D0	COEFKRES	1.0D0	
	COEFKM	1.D-5	COEFKD	2.D-5	COEFKR 3.D-5
	SEGMENT	p0core	p2core		
	XXXXXXX3	ISO 9	DIAM	d_ch	d_wchx
	REFLECT 1	FRACNEU	0.D0	FRACKR	0.5D0
	HPERIM	CONST	p_ch		
	PROFILE	ZKPOWNR	1.0D0		
		AZKREF	1.0D0		
	SEGMENT	p2core	p3core		
	XXXXXXX3	ISO 6	DIAM	d_ch	d_wchf
	XXXXXXX3	ISO 3	DIAM	d_wchf	d_wchx
	DOPPLER 2	FRACNEU	1.0D0	FRACRES	1.0
		MODERAT	1		
	HPERIM	CONST	p_ch		
	PROFILE	ZKPOWNR	1.0D0		
		ZKPOWRS	1.0D0		
		AZKMOD	1.0D0		
		AZKDOP	1.0D0		
	SEGMENT	P3core	P5core		
	XXXXXXX3	ISO 9	DIAM	d_ch	d_wchx
	REFLECT 1	FRACNEU	0.D0	FRAKKR	0.5D0
	HPERIM	CONST	p_ch		
	PROFILE	ZKPOWNR	1.0D0		
		AZKREF	1.0D0		
	LOSS	RADEXT			
		EEXT 0.8D0	TEXT 90.D0 ;		

2)

plaql =	FUELPLAQ	axac	HTR	EXTERNAL	CYLINDER
	COEFKNEU	1.0D0	COEFKRES	1.0D0	
	FCOEFKM	0.02d0	0.034d0	0.005d0	0.007d-1
	FCOEFKD	0.01d0	0.01d0	0.037d0	0.049d0 0.0065
	FCOEFKR	0.13	0.134	0.115	0.017d-1
	SEGMENT	p0core	p2core		
	XXXXXXX3	ISO 9	DIAM	d_ch	d_wchx
	REFLECT 1	FRACNEU	0.D0		
	HPERIM	CONST	p_ch		
	PROFILE	ZKPOWNR	1.0D0		
	SEGMENT	p2core	p3core		
	XXXXXXX3	ISO 6	DIAM	d_ch	d_wchf

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 249/851

XXXXXXX3	ISO 3	DIAM	d_wchf	d_wchx
DOPPLER 2	FRACNEU	1.0D0	FRACRES	1.0
	MODERAT	1		
HPERIM	CONST	p_ch		
PROFILE	ZKPOWRN	1.0D0		
	ZKPOWRS	1.0D0		
SEGMENT	P3core	P5core		
XXXXXXX3	ISO 9	DIAM	d_ch	d_wchx
REFLECT 1	FRACNEU	0.D0		
HPERIM	CONST	p_ch		
PROFILE	ZKPOWRN	1.0D0		
LOSS	RADEXT			
	EEXT	0.8D0		
	HEXT	21.D0	TEXT	90.D0 ;

#### FNR application

1)

ass1 =	FUELPLAQ	canal1		
	FNR	METAL		
	INTERNAL	CYLINDER		
COEFKNEU	1.0D0	COEFKRES	1.0D0	
COEFKD	1.D-5			
COEFKFA	1.D-5			
COEFKCR	1.D-5	NOAVVERAGE		
COEFKCA	1.D-5	NOAVVERAGE		
LAW	LOIRAD			
NCHANNEL	nbcrayons			
SEGMENT	PASS1	PASS2		
XXXXXXX1	ISO 6	DIAM	d0	d1
XXXXXXX2	ISO 2	DIAM	d1	d2
<b>REFLECT</b>	1	FRACNEU	0.D0	
HPERIM	CONST	perim		
PROFILE	ZKPOWRN	0.0D0		
	AZKCLAR	FZHT9	ABSMESH	
	AZKCLAA	FZHT9	ABSMESH	
SEGMENT	PASS2	PASS4		
XXXXXXX1	ISO 6	DIAM	d0	d1
XXXXXXX2	ISO 2	DIAM	d1	d2
<b>DOPPLER</b>	1	FRACNEU	1.D0	
FRACRES	1.D0			
HPERIM	CONST	perim		
PROFILE	ENRICH	ENRLIST		
	TAUREMP	95.5D-2		
	ZKPOWRN	FZPOW		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 250/851

ZKPOWRS	FZPOW				
AZKDOP	FZDOP				
AZKFUEA	FZFUEL				
AZKCLAR	FZHT9	ABSMESH			
AZKCLAA	FZHT9	ABSMESH			
SEGMENT	PASS4	PASS6			
XXXXXXX1	ISO 6	DIAM	d0	d1	
XXXXXXX2	ISO 2	DIAM	d1	d2	
<b>REFLECT</b>	1	FRACNEU	0.D0		
HPERIM	CONST	perim			
PROFILE	ZKPOWRN	0.0D0			
	AZKCLAR	FZHT9	ABSMESH		
	AZKCLAA	FZHT9	ABSMESH	;	
ENRLIST	= REALLIST	0.0	25.5D-2	0.0	25.5D-2
		25.5D-2	0.0;		
FZPOW =	REALLIST	0.73	0.96	1.10	
1.15	1.08	0.91	0.69		
;					
FZHT9	= REALLIST	4.04D-04	4.04D-04	4.04D-04	1.15D-01
3.22D-01	4.75D-01	5.25D-01	4.54D-01		
2.88D-01	8.52D-02	-4.68D-02	-4.20D-03		
-4.20D-03	-4.20D-03	-4.20D-03	-5.89D-04 ;		

2)

HT1 =	FUELPLAQ	canal1	FNR		
	EXTERNAL	CYLINDER			
COEFKNEU	0.0D0				
COEFKV	1.D-5	NOAVVERAGE			
COEFKDR	1.D-5	NOAVVERAGE			
COEFKDA	1.D-5	NOAVVERAGE			
<b>COEFKP</b>	<b>1.D-5</b>				
LAW	LOIRAD				
SEGMENT	PASS1	PASS3			
XXXXXXX3	ISO 2	DIAM	dhtint	dhtext	
<b>HEXDUCT</b>	1	FRACNEU	0.D0		
HPERIM	CONST	perim			
PROFILE	ZKPOWRN	0.0D0			
	AZVOID	FZVOID	ABSMESH		
	AZKDUCR	FZHT9	ABSMESH		
	AZKDUCA	FZHT9	ABSMESH		
SEGMENT	PASS3	PASS4			

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 251/851

XXXXXXX3	ISO 2	DIAM	dhtint	dhtext
<b>HEXDUCT</b>	1	<b>CONTPAD</b>		
FRACNEU	0.D0			
HPERIM	CONST	perim		
PROFILE	ZKPOWR	0.0D0		
	AZKVOID	FZVOID	ABSMESH	
	AZKDUCR	FZHT9	ABSMESH	
	AZKDUCA	FZHT9	ABSMESH	
SEGMENT	PASS4	PASS7		
XXXXXXX3	ISO 2	DIAM	dhtint	dhtext
<b>HEXDUCT</b>	1	FRACNEU	0.D0	
HPERIM	CONST	perim		
PROFILE	ZKPOWR	0.0D0		
	AZKVOID	FZVOID	ABSMESH	
	AZKDUCR	FZHT9	ABSMESH	
	AZKDUCA	FZHT9	ABSMESH	;
FZFUEL =	REALLIST	0.64	0.95	1.19
1.27		0.88	0.57 ;	
FZHT9 =	REALLIST	4.04D-04	4.04D-04	4.04D-04
1.15D-01	3.22D-01	4.75D-01	5.25D-01	
4.54D-01	2.88D-01	8.52D-02	-4.68D-02	
-4.20D-03	-4.20D-03	-4.20D-03	-4.20D-03	
-5.89D-04 ;				

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 252/851

65

## GEOM DIRECTIVE

The geometry of an element is acquired by the **GEOM** directive in *data block*.

The types of elements authorised in this directive are AXIAL, TEE, VOLUME or THREED.

### 65.1 Geometry of an 1-D element

For an axial element, variations in the geometrical characteristics are defined on vector points. They must belong to the element mesh. Points must be given in mesh order, beginning with the first one and ending with the last one.

There are 2 types of applications:

1. standard application, where geometrical characteristics defined on vector points are section, perimeter and size , and where geometrical characteristics of intermediate points will be calculated by interpolation
2. LBB application is used in case of leak-before-break, where geometrical characteristics are defined on vector points, and where geometrical characteristics of intermediate points will be calculated by a specific formula (case of a convergent or a divergent), in case of 3 different shapes (rectangle, circle, oblate ellipse).

#### Associated Keywords

AXIAL, HYDR, MESH, SINGULAR

#### Syntax

#### 65.1.1 Standard application

<b>GEOM</b>	elem				
	P1	SECT	sect1	PERI	perim1
		SIZE	size1		
	P2	SECT	...		
	;				

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 253/851

## 65.1.2 Case of (LBB) Leak-Before-Break application

<b>GEOM</b>	<b>Elem</b>			
	(P1)	and	P2)	<b>LBB</b>
		<b>DEUXC1</b>	deuxc1	<b>DEUXC2</b>
		<b>DELTA1</b>	delta1	<b>DELTA2</b>
		<b>RECT</b>		deuxc2
		or	<b>CERC</b>	delta2
		or	<b>ELLAP</b>	
				;

<b>elem</b>	: axial element	<b>To be repeated as many times as needed</b>
<b>P1</b>	: vector point(s) which must belong to the element mesh.	
<b>or (P1 and P2)</b>		
<b>LBB</b>	optional keyword indicating that LBB model will be applied (only with 2 points (P1 and P2) defined before)	
<b>SECT sect1</b>	standard case only	
	: keyword followed by a real number > 0. defining the flow section ( $m^2$ ).	
<b>PERI perim1</b>	standard case only : keyword followed by a real number > 0. defining the friction perimeter (m).	
<b>SIZE size1</b>	standard case only : keyword followed by a real number > 0. defining the size (m).	
<b>DEUXC1</b>	<b>LBB</b> application only : keyword followed by a real number > 0. defining the larger dimension of the section in P1	
deuxc1	<b>LBB</b> application only : keyword followed by a real number > 0. defining the larger dimension of the section in P2	
<b>DEUXC2</b>	<b>LBB</b> application only : keyword followed by a real number > 0. defining the smaller dimension of the section in P1 (= deuxc1 in case of circle shape, and < 0.1 deuxc1 in case of oblate ellipse)	
deuxc2	<b>LBB</b> application only : keyword followed by a real number > 0. defining the smaller dimension of the section in P2 (= deuxc2 in case of circle shape, and < 0.1 deuxc2 in case of oblate ellipse)	
<b>DELTA1</b>	<b>LBB</b> application only : keyword indicating that the current section is a rectangle, a circle or an oblate ellipse	
delta1		
<b>DELTA2</b>		
delta2		
<b>RECT</b>		
<b>or CERC</b>		
<b>or ELLAP</b>		

**Size definition** (see user's manual and user guidelines): the size corresponds to the maximum transverse dimension of a pipe or junction. Thus it is the diameter for a circular pipe, the major width for a rectangular section, the external diameter for an annular space, the dimension of the rod bundle core for an axial element of rod bundle flow geometry, etc...

The size value is used for physical correlations (interfacial friction) in annular geometry cases and at junctions with volumes to determine flow distributions in sub-volumes particularly for horizontal junctions the influence zone calculated is (1.2\*size). The size value of a mesh connected to a Tee-branch is also used in the elevation calculation of the Tee junction during the elevation control calculation of the circuit.

**NB :**

If the axial element has a weight, the geometrical characteristics (flow section, perimeter) have to be given for one pipe. In a same element can be defined segments with standard application and segment with **LBB** application.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 254/851

<b>Example</b>
----------------

1)

GEOM	downco				
	P1	SECT	2.9391	PERI	24.24
		SIZE	4.100		
	(P2)	AND	P3)	SECT	2.4863
		PERI	24.50	SIZE	4.100
	P4	SECT	3.4922	PERI	23.92
		SIZE	4.100 ;		

2)

coeurmoy =	AXIAL				
	moyinf	USTREAM	moysup	DSTREAM	
	WEIGHT	41448	;		

GEOM	coeurmoy				
	(P15	AND	P18)	SECT	9.311D-5
	PERI	3.348D-2			
	SIZE	0.01445	;		

3)

GEOM	leakax				
	P1				
	(P2	AND	P3)		
	SECT	7.023D-7	PERI	7.16D-2	SIZE
	LBB				4.D-5
		DEUXC1	3.6D-2	DEUXC2	9.0D-3
		DELTA1	2.5D-5	DELTA2	1.6D-5
		ELLAP	;		

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 255/851

## 65.2 Geometry of an TEE-branch element

TEE is not an element as in previous CATHARE versions. It is a lateral branch which has to be linked to an axial element (see **TEE** operator and **CONNECT** directive).

**Warning :** The section of the axial element should be constant on the mesh which supports the Tee-branch.

### Associated Keywords

**TEE, SINGULAR, CONNECT, ENABLE, DISABLE**

### Syntax

<b>GEOM</b>	teename			
<b>LENGTH</b>	zlength	<b>(WEIGHT</b>	iweight)	
<b>(TECOND)</b>	<b>(JETPUMP)</b>			
<b>SECT</b>	sect	<b>(SECTOT</b>	sectot)	
<b>(DELTAZ</b>	<b>PERI</b>	peri	<b>SIZE</b>	size
<b>INCLINED</b>	<b>deltz</b>			
	coss			
	or	<b>TOP</b>		
	or	<b>BOTTOM</b>		
	or	<b>HORIZONT</b>	<b>ELEV</b>	elev
	<b>ANGLE</b>	angle	;	

**teename** : name of TEE object defined by the user.

**LENGTH length** : keyword followed by a real number  $> 0$ . defining the length reckoned from the edge of the pipe (m).

**WEIGHT iweight** : OPTIONAL keyword. If it is used, it is followed by an integer  $> 0$ , defining the weight of the junction.

**Definition :** the weight is the number of identical tees connected to the same axial element at the same location. The default value is 1.

**TECOND** : OPTIONAL keyword used to activate special condensation model in the axial connected mesh. It should be used for large injections of cold water (in case of a meshed accumulator for example).

**JETPUMP** : OPTIONAL keyword. It triggers the appropriate momentum contributions from the TEE to the AXIAL to model jetpump systems. If used, the tee-branch WEIGHT must necessarily be equal to 1.

**SECT sect** : keyword followed by a real number  $> 0$ . defining a flow section ( $m^2$ ).

**SECTOT sectot** : Optional keyword followed by a real number  $> 0$ . to be used to model jetpump systems. If defines the overall section of the injector. It creates automatically a load loss coefficient which takes into account the overall section of the injector.

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 256/851

<b>PERI peri</b> <b>SIZE size</b> <b>DELTAZ deltz</b> <b>INCLINED coss</b> <b>ELEV elev</b> <b>ANGLE angle</b>	: keyword followed by a real number $> 0$ . defining the friction perimeter (m). : keyword followed by a real number $> 0$ . defining the diameter of the junction (m). : OPTIONAL keyword followed by a real number $> 0$ . defining the integration length (m). : keyword followed by a real number $-1 \leq coss < 1$ . defining the cosine of the angle between the branch and the ascending vertical. In the case of a horizontal branch, the pair "INCLINED coss" may be replaced by the keyword <b>HORIZONT</b> . In the case of a vertical branch, it may be replaced by <b>TOP</b> or <b>BOTTOM</b> depending on the direction of the branch. : keyword followed by a real number $0 \leq elev \leq 1$ . defining the normalised elevation of the T-branch with respect to the bottom of the main pipe : -ELEV 0. : T-branch below main pipe, -ELEV 1. : T-branch on main pipe, -ELEV 0.5 : lateral T-branch half way up the main pipe. : keyword followed by a real number defining the angle, in radians, between the axial element (with the direction given by the meshing) and the tee branch.
---	--

### Example

```

tepressu = tepexp          DSTREAM ;
TEE

GEOM      tepressu
LENGTH   1.828           WEIGHT    1
SECT     0.099315         PERI     1.1171
HORIZONT ELEV            SIZE      0.3556
                  0.5        ANGLE    1.5708 ;

```

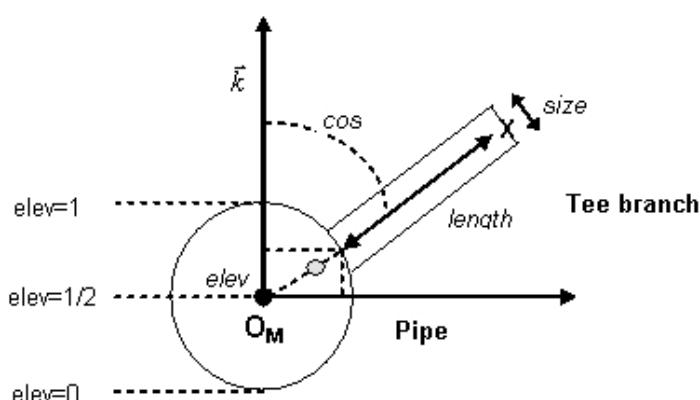


Figure 65.2.1: GEOM for TEE : Front sectional view

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/</i> <i>RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 257/851

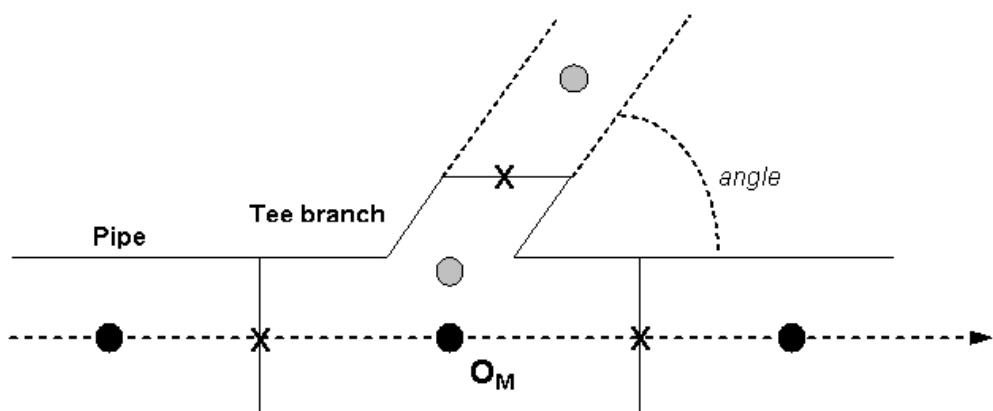


Figure 65.2.2: GEOM for TEE : side view

	<p style="margin: 0;">DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
<b>Document technique DEN</b>	Page 258/851

## 65.3 Geometry of an 0-D element

For a volume, the following items **must** be given in the following order : first a list of optional information items relating to the whole element, followed by the geometrical definition of the capacity and finally the geometrical description of the junctions. The information related to the entire capacity can be given in any order. The geometrical definition must be given with **increasing elevations**, with the origin being the base of the capacity. Junctions can be described in any order.

A junction may be **horizontal** or **vertical** or **inclined**.

How to define the elevation of a junction ?

1. for an horizontal junction, use ELEV keyword and the value of the elevation of the junction.
2. for a vertical junction, use BOTTOM or TOP keyword.
3. for an inclined junction use BOTTOM or TOP or ELEV keyword and the value of the elevation of the junction.

Three kinds of volumes may be defined based on specific GEOM directive syntaxes :

1. the standard model : it is for a volume without any specificity.
2. the **separator** model : it is a volume with **3 special junctions and only 3**.
3. the **dryer** model : it is a volume with **3 junctions and only 3** having **1 special junction**. A perfect dryer sub-model and a mechanistic one are implemented.

These three models only differ in the junction definition.

### Associated Keywords

VOLUME, SINGULAR

### Syntax

#### 65.3.1 Standard 0-D module

<b>GEOM</b>	elem	
	(UPPLEN      or	UPPLENWS)
	(HYDRDIAM    zdiam1)	

cotinf	sectinf	
coti	secti	...
cotsup	sectsup	

or

<b>GAUGE</b>		
volinf	zinf	
voli	zi	
volsup	zsup	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 259/851

or

<b>GAUGE</b>					
<b>LAW</b>	lawvol				
<b>TOP</b> or <b>BOTTOM</b> or <b>ELEV</b> zcot1 <b>(LENGTH</b> zlength1) <b>ANNULSPA</b> or <b>SEPDRYER)</b> <b>(WEIGHT</b> iweight) <b>PERI</b> perim1 <b>SIZE</b> size1 <b>(STANDARD</b> or <b>SECT</b> sect1 <b>HORIZONT</b> or <b>INCLINED</b> coss <b>(L_INFLUEN</b> linfl) <b>DELTAZ</b> or <b>DELTAZ</b> deltazl <b>VERTICAL</b> or					
juncti junctj      ... ;					

### 65.3.2 Separator 0-D module

<b>GEOM</b>	elem cotinf coti cotsup	sectinf secti sectsup	...		
Junct1 <b>BOTTOM</b> zcot1 <b>LENGTH</b> zlength1 <b>(WEIGHT</b> iweight) <b>SEPINLET</b> xco <b>XCO</b> <b>SECT</b> sect1 <b>PERI</b> perim1 <b>SIZE</b> size1 <b>VERTICAL</b>					
Junct2 <b>BOTTOM</b> zcot1 <b>LENGTH</b> zlength1 <b>(WEIGHT</b> iweight) <b>SEPSIDE</b> <b>SECT</b> sect2 <b>PERI</b> perim2 <b>SIZE</b> size2 <b>VERTICAL</b>					
Junct3 <b>TOP</b> <b>LENGTH</b> zlength3 <b>(WEIGHT</b> iweight3) <b>SEPOUT</b> <b>SECT</b> sect3 <b>PERI</b> perim3 <b>SIZE</b> size3 <b>VERTICAL</b> ;					

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 260/851

### 65.3.3 Dryer 0-D module

<b>GEOM</b>	elem					
	cotinf	sectinf				
	coti	secti	...			
	cotsup	sectsup				
Junct1						
<b>BOTTOM</b>	<b>LENGTH</b>		<b>zlength1</b>			
(WEIGHT	iweight)					
(MINDRYER)						
<b>SECT</b>	sect1	<b>PERI</b>	perim1	<b>SIZE</b>		size1
<b>VERTICAL</b>						
Junct2						
<b>BOTTOM</b>	<b>LENGTH</b>		<b>zlength2</b>			
(WEIGHT	iweight2)					
<b>SECT</b>	sect2	<b>PERI</b>	perim2	<b>SIZE</b>		size2
<b>VERTICAL</b>						
Junct3						
<b>TOP</b>	<b>LENGTH</b>		<b>zlength3</b>			
(WEIGHT	iweight3)					
<b>DRYER</b>	or	<b>MDRYER</b>				
	<b>VVLOW</b>	vvlow				
	<b>VVUP</b>	vvup				
<b>SECT</b>	<b>OFFSET</b>		<b>offset</b>		)	
	sect3	<b>PERI</b>	perim3			
	<b>SIZE</b>	size3				
<b>VERTICAL</b>	;					

**elem** : volume element name  
**UPPLEN** : OPTIONAL keyword for modeling an upper plenum for a PWR or CP1 reactor type (it result in a specific phase separation correlation). (**Standard volume only**).  
**or**  
**UPPLENWS** : same as UPPLLEN, must be used with an upper plenum without internal structure as BETHSY. (**Standard volume only**).  
**HYDRDIAM** : OPTIONAL keyword. When it is used, it is followed by a real number  $> 0.$ , defining the hydraulic diameter used to calculate mass and energy transfers, wall transfers. The default value of the hydraulic diameter is calculated by the code : it is an average value calculated from the cross sections defining the capacity. (**Standard volume only**).  
**zdiam1**

**cotinf** : real number  $\geq 0.$ , defining the origins of the elevations of cross-section changes (m), followed by:  
**sectinf** : real number  $> 0.$ , defining the cross-section ( $m^2$ ),  
**To be repeated as many times as needed**  
**coti** : real number  $> 0.$  defining an elevation of cross-section change (m), followed by :  
**secti** : real number  $> 0.$  defining the cross-section ( $m^2$ ).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 261/851

**cotsup** : real number > 0. defining the height of the capacity (m), followed by :  
**sectsup** : real number > 0. defining the cross-section ( $m^2$ ).

or  
**GAUGE** : Optional keyword that allows users to define volume as level function of the capacity.  
It is followed by:  
**volinf** : real number equal to 0., defining the volume of the origin elevation ( $m^3$ ), followed by:  
**zinf** : real number defining origin elevation (m)

**To be repeated as many times as needed**  
**voli** : real number > 0. defining the volume at the ith elevation ( $m^3$ ), followed by :  
**zi** : real number > 0. defining the  $i^{th}$  elevation (m).  
  
**volsup** : real number > 0. defining the capacity ( $m^3$ ) of the volume, followed by :  
**zsup** : real number > 0. defining the elevation of the volume (m).

or  
**LAW** : Optional keyword that allows users to define volume as level function of the volume by a LAW  
**lawvol** : Name of the law

For each junction, the following keywords are defined :

**juncti** : junction which must belong to the element.  
**ELEV zelev1** : keyword followed by a real number, defining the elevation of the junction, measured with respect to the bottom of the capacity.  $0. < zelev1 <$  height of the capacity. The junction is located on the side of the capacity and is horizontal or inclined (m).  
  
**or BOTTOM** : the junction is vertical or inclined, located at the bottom of the capacity.  
**or TOP** : the junction is vertical or inclined, located at the top of the capacity.  
**LENGTH zlength1** : OPTIONAL keyword followed by a real number >0., defining the penetration length of the junction within the capacity (m).  
**WEIGHT iweight** : OPTIONAL keyword. When it is used, it is followed by an integer > 0, defining the weight of the junction.  
**Definition** : the weight of the junction refers to the number of elements of the same type connected to the junction. The default value is 1.

*See note 1 and examples in GEOM directive for an axial element.*

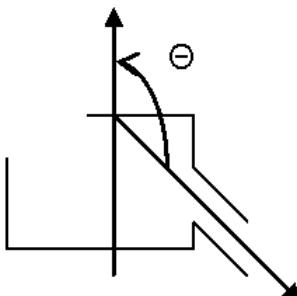
#### **Special adds for a standard volume**

**STANDARD** or **ANNULSPA** or **SEPDRYER** : OPTIONAL keyword : STANDARD or ANNULSPA or SEPDRYER. The default junction is of the STANDARD type. If the keyword ANNULSPA is used, it results in a phase distribution law for a junction of the downcomer/container bottom type. If the keyword SEPDRYER is used, it results in a phase distribution law for a junction of the separator dryer/SG cavity type.

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 262/851

**SECT sect1** : keyword followed by a real number  $> 0.$ , defining the flow section ( $m^2$ ).  
**PERI perim1** : keyword followed by a real number  $> 0.$ , defining the friction perimeter (m).  
**SIZE sizel** : keyword followed by a real number  $> 0.$ , defining the size (m).  
**L\_INFLUEN linfl** : OPTIONAL keyword followed by a real number  $> 0.$ , defining the influence length (m) of the junction used to calculate the flow distribution coefficients at junction. By default this length is calculated by **CATHARE**. This option also activates specific distribution coefficients for sodium fluid only.  
**DELTAZ deltalz** : OPTIONAL keyword followed by a real number  $> 0.$ , defining the integration length (m).  
**HORIZONT** or **VERTICAL** or **INCLINED** : keyword HORIZONT or VERTICAL or INCLINED, characterizing the inclination of the junction. Keyword INCLINED must be followed by a real number defining the cosine of the angle between the outgoing direction and the upward direction.  
This real number must be :  
 $0 < \cos < 1.$  if keyword elevation is TOP  
 $-1 < \cos < 0.$  if keyword elevation is BOTTOM  
 $-1 < \cos < 1.$  if keyword elevation is ELEV  
**N.B** :For the influence coefficient  $\beta$  calculation, junctions between volume and axial elements are considered as vertical beyond  $60^\circ$  of incline with the vertical axis.

Example :



In this case,  $\cos -0.5$  is the value to use.

Figure 65.3.1: GEOM for Volume : geometry configuration for inclined junctions

#### Special adds for separator volume

**junct1** : name of the inlet junction. This junction must be a bottom vertical junction and must have the **SEPINLET** keyword after the lenght or weight definition.  
**xco** : real number between 0. and 1., defining the liquid quality imposed at the outlet junction (carry over).  
**xcu** : real number between 0. and 1., defining the gas quality imposed at the side junction (carry under).  
**junct2** : name of the junction devoted to the liquid extraction. This junction must be a bottom vertical junction and must have the **SEPSIDE** keyword after the length or weight definition.  
**junct3** : name of the outlet junction. This junction must be a top vertical junction and must have the **SEPOUT** keyword after the length or weight definition.

#### Special adds for dryer volume

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<b>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</b>
	<b>Document technique DEN</b>	Page 263/851

<b>junct1</b>	name of the inlet junction. This junction must be a bottom vertical junction. In case of a <b>mechanist dryer only</b> , keyword <b>MINDRYER</b> has to be used after the length or weight definition.
<b>junct2</b>	: name of the junction devoted to liquid extraction. This junction must be a bottom vertical junction.
<b>junct3</b>	: name of the outlet junction. This junction must be a top vertical junction and must have the <b>DRYER</b> or <b>MDRYER</b> (in case of a mechanist dryer) keyword after the length or weight definition. If keyword MDRYER is used, the three following keywords must be used :
<b>VVLOW vvlow</b>	: keyword followed by a real positive number used to compute the critical inlet liquid quality. <b>Mechanist sub-model of dryer only</b> .
<b>VVUP vvup</b>	: keyword followed by a real positive number, greater than vvlow, used to compute the critical inlet liquid quality. <b>Mechanist sub-model of dryer only</b> .
<b>OFFSET offset</b>	: keyword followed by a real number between 0 and 1, used to compute the efficiency of the dryer. <b>Mechanist sub-model of dryer only</b> .

### Example

#### Standard volume

1)

GEOM	voldown					
	0.	2.9391				
	0.2		2.9391			
	3.1679		1.1873			
downint	ELEV	1.0732	LENGTH	O	WEIGHT	2
	SECT	0.6474	PERI	2.852	SIZE	0.9079
	HORIZONT					
downromp	ELEV	1.0732	LENGTH	0.	WEIGHT	
	SECT	0.6474	PERI	2.852	SIZE	0.9079
	HORIZONT					
downcouv	TOP	LENGTH	O	WEIGHT	24	
	SECT	8.1602e-4	PERI	0.1012	SIZE	3.910
	VERTICAL					
downfond	BOTTOM	LENGTH	O.	WEIGHT		
	SECT	2.9391	PERI	24.424	SIZE	4.1
	VERTICAL					
;						

2)

GEOM	volpre					
	0.	2.9391				
	0.2		2.9391			
	3.1679		1.1873			
cotvol	ELEV	1.0732	LENGTH	O	WEIGHT	2
	SECT	0.6474	PERI	2.852	SIZE	0.907
	INCLINED	0.5				
dowvol	TOP	LENGTH	O	WEIGHT	24	
	SECT	8.1602e-4	PERI	0.1012	SIZE	3.910

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 264/851

```

downfond INCLINED    0.5
          BOTTOM      LENGTH   O.
          SECT        2.9391   PERI     24.424    SIZE      4.1
          INCLINED   -0.5
;

3)
GEOM      colche
          0.         49.0
          2.3       49.0
jcolchde  BOTTOM      LENGTH   O.
          SECT        49.0     PERI     72.0     SIZE      7.9
          L_INFLUEN  0.01    VERTICAL
;

;

```

#### Separator volume

```

VOL =      VOLUME
          JENTREE    USTREAM
          JRETOUR   DSTREAM
          JSORTIE   DSTREAM ;
GEOM VOL
          0.0       1.0
          1.0       1.0
          2.0       1.0
JENTREE   BOTTOM
          LENGTH    0.0
          SEPINLET XCO     0.01    XCU      0.01
          SECT      PERI     0.3     SIZE      0.1
          VERTICAL
JRETOUR   BOTTOM
          LENGTH    0.0
          SEPSIDE
          SECT      0.1     PERI     0.3     SIZE      0.1
          VERTICAL
JSORTIE   TOP
          LENGTH    0.0
          SEPOUT
          SECT      0.1     PERI     0.3     SIZE      0.1
          VERTICAL
;
```

#### Dryer Volume

##### 1. Perfect dryer

```

VOL =      VOLUME
          JENTREE    USTREAM
          JRETOUR   DSTREAM
          JSORTIE   DSTREAM ;
GEOM VOL
;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 265/851

0.0	1.0		
1.0	1.0		
2.0	1.0		
JENTREE	BOTTOM		
	SECT	0.1	PERI
	SIZE	0.1	
	VERTICAL		
JRETOUR	BOTTOM		
	LENGTH 0.0		
	SECT	0.1	PERI
	SIZE	0.1	
	VERTICAL		
JSORTIE	TOP		
	LENGTH 0.0		
	<b>DRYER</b>		
	SECT	0.1	PERI
	SIZE	0.1	
	VERTICAL ;		

## 2. Mechanist dryer

VOL =	VOLUME	JENTREE	USTREAM		
	JRETOUR	DSTREAM			
	JSORTIE	DSTREAM ;			
GEOM VOL					
	0.0	1.0			
	1.0	1.0			
	2.0	1.0			
	JENTREE	BOTTOM			
		SECT	0.1	PERI	0.3
		SIZE	0.1		
		VERTICAL			
	JRETOUR	BOTTOM			
		LENGTH 0.0			
		SECT	0.1	PERI	0.3
		SIZE	0.1		
		VERTICAL			
	JSORTIE	TOP			
		LENGTH 0.0			
		<b>DRYER</b>	VVLOW	5.0	VVUP 10.0
		OFFSET	0.1		
		SECT	0.1	PERI	0.3
		SIZE	0.1		
		VERTICAL	;		

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 266/851</a>

## 65.4 Geometry of an 3-D element

Used after the **MESH** operator, the **GEOM** operator applied to a threed element enables the definition of the hydraulic mesh volumes and the flow areas of the element.

This operator is **compulsory** in the definition of a **threed** module and must appear in the data block.

**NB :** For all information about numbering, please refer to the user manuel appendix “NUMBERING in THREED elements”

### Associated Keywords

THREED, CONNECT, HYDR, MESH, PHYSCALE, SINGULAR

### Syntax

**GEOM** elem

*Volume of fluid per mesh cell*

<b>VOLUME</b>	<b>LISTVOL</b>	vol1	vol2	...	voln
or	<b>DEFAULT</b>	volume			
or	<b>GEOMETRI</b>	<b>NO_POROS</b>			
or	<b>GEOMETRI</b>	<b>POROS</b>	<b>DEFAULT</b>	poros	

and	<b>SEGMENT</b>	begpt	endpt		
	<b>VALUE</b>	volume	or	porosity	
or	<b>LISTPOIN</b>	npt	<b>VALUE</b>	volume	or
		i1 ...	inpt		porosity
or	<b>ZONE</b>	zone_name	volume	or	
or	<b>ZONE</b>	ibe	ien		
		jbe	jen		
		kbe	ken		
		volume	porosity		
		or			

*Flow area / mesh cell face*

<b>AREAEDGE</b>	<b>X</b>	or	<b>AREAEDGE</b>	<b>TETA</b>	
	<b>LISTFA</b>	area1	area2	...	arean
or	<b>DEFAULT</b>	area			
or	<b>GEOMETRI</b>	<b>NO_POROS</b>			
or	<b>GEOMETRI</b>	<b>POROS</b>	<b>DEFAULT</b>	poros	

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 267/851</a>

and	<b>SEGMENT</b>	begpt <b>VALUE</b>	endpt area	or	porosity
or	<b>LISTPOINT</b>	npt i1	<b>VALUE</b> ...	area inpt	or porosity
or	<b>FXZONE</b>	vx_zone_name	Area	or	porosity
or	<b>FXZONE</b>	ibe			
	area	ien	jbe	jen	kbe
		oporosity			ken
<b>AREAEDGE</b>	<b>Y</b>	or	<b>AREAEDGE</b>	<b>R</b>	
	<b>LISTFA</b>	area1	area2	...	arean
or	<b>DEFAULT</b>	area			
or	<b>GEOMETRI</b>	<b>NO_POROS</b>			
or	<b>GEOMETRI</b>	<b>POROS</b>	<b>DEFAULT</b>	poros	
and	<b>SEGMENT</b>	begpt <b>VALUE</b>	endpt area	or	porosity
or	<b>LISTPOINT</b>	npt i1	<b>VALUE</b> ...	area inpt	or porosity
or	<b>FYZONE</b>	vy_zone_name	Area	or	porosity
or	<b>FYZONE</b>	ibe			
	area	ien	jbe	jen	kbe
		oporosity			ken
<b>AREAEDGE</b>	<b>Z</b>	or	<b>AREAEDGE</b>	<b>TETA</b>	
	<b>LISTFA</b>	area1	area2	...	arean
or	<b>DEFAULT</b>	area			
or	<b>GEOMETRI</b>	<b>NO_POROS</b>			
or	<b>GEOMETRI</b>	<b>POROS</b>	<b>DEFAULT</b>	poros	
and	<b>SEGMENT</b>	begpt <b>VALUE</b>	endpt area	or	porosity
or	<b>LISTPOINT</b>	npt i1	<b>VALUE</b> ...	area inpt	or porosity
or	<b>FZZONE</b>	vz_zone_name	Area	or	porosity
or	<b>FZZONE</b>	ibe			
	area	ien	jbe	jen	kbe
		oporosity			ken
	;				

**GEOM elem** : Directive to describe the fluid geometrical characteristics, i.e. : the fluid volume for every mesh cell (VOLUME) and the fluid area for every mesh cell face (AREAEDGE). These definitions can be made directly or using the porosity definition. Once the choice of the definition type is made it cannot be changed.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 268/851

**NB : porosity definition**

- Volume porosity is : volume (available for the fluid in the mesh) /volume (mesh)
  - Surface porosity is : area (available for the fluid in the face) /area (face)
- volume (mesh) and area (face) refer to values calculated using the data given in the MESHSIZE operator in the MESH directive.
- A porosity value is always defined between 0. and 1..

**VOLUME**

: Keyword introducing the fluid volume in mesh cell. **It is followed by :**

**LISTVOL**

**vol1**

...

**voln**

or

**DEFAULT volume**

: Keyword followed by a list of n real numbers equal to the different fluid volume ( $m^3$ ) for each mesh cell (referring to the scalar meshes numbering). In that case, the fluid volume has to be specified for all the mesh cells of the threed element.

: Keyword followed by a real number equal to the volume of a mesh ( $m^3$ ). This real value is applied to all the mesh cells of the *elem* element by default.  
This default value can be changed in selected regions using several keywords : see below for the different options.

or

**(using porosity notion)**

**GEOMETRI**

: Keyword indicating that the fluid volume will be defined using the porosity notion.

It is followed by :

: Keyword indicating that the porosity value is set to 1. for all the meshes : the fluid volume per mesh is set to its geometrical volume.

or

**POROS**

**DEFAULT poros**

: Keywords followed by a real number *poros*,  $0. < poros < 1.$ , defining the porosity of each mesh. The real value is applied to all the mesh cells of the *elem* element by default.

This default value can be changed in selected regions using several keywords : see below for the different options.

**AREAEDGE X**

: Keyword introducing the fluid area on X vector faces.

**AREAEDGE Y**

: Keyword introducing the fluid area on Y vector faces.

**AREAEDGE Z**

: Keyword introducing the fluid area on Z vector faces.

**Each of these keywords is followed by :**

**LISTFA**

**area1**

...

**arean**

or

**DEFAULT**

**area**

: Keyword followed by a list of n real numbers equal to the different fluid area ( $m^2$  ) for each face in the selected direction (referring to vector numbering). In that case, the fluid area has to be specified for all the faces in the selected direction of the threed element.

: Keyword followed by a real number equal to the fluid area of a face ( $m^2$  ). The real value is applied to all the faces of the *elem* element by default.

This default value can be changed in selected regions using several keywords : see below for the different options.

or

**(using porosity notion)**

**GEOMETRI**

: Keyword indicating that the fluid area will be defined using the porosity notion.

It is followed by

	<p style="margin: 0;">DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
<b>Document technique DEN</b>	Page 269/851

<b>NO_POROS</b> or <b>POROS</b> <b>DEFAULT poros</b>	: Keyword indicating that the porosity value is set to 1. for all the faces in the selected direction : the fluid area is set to its geometrical value for each cell face.
	: Keywords followed by a real number, $0. < \text{poros} < 1.$ , defining the porosity of a face. The real value is applied to all the faces of the <i>elem</i> element by default. This default value can be changed in selected regions using several keywords : see below for the different options.
<b>To change values of volume, area or (volume or surface) porosity in selected regions of the element, the following options are listed :</b>	
<b>SEGMENT</b>	: Keyword defining a continuous segment of meshes or faces from <i>begpt</i> to <i>endpt</i> for which a selected variable (volume, area or porosity) is equal to the same value. This option may be repeated as many time as needed. It is followed by :
<b>begpt endpt</b>	: two integers defining the <b>CATHARE</b> coordinates of the first and last points of the segment : <ul style="list-style-type: none"> <li>- referring to scalar mesh numbering for volume or volume porosity variables</li> <li>- referring to vector node numbering for area or surface porosity variables</li> </ul>
<b>VALUE</b> <b>volume</b> or <b>area</b> or <b>porosity</b>	: Keyword followed by a real number (value of the selected variable).
<b>LISTPOIN</b>	: Keyword to indicate that a list of meshes or faces have the same volume, area or porosity. This option may be repeated as many times as needed. It is followed by :
<b>npt</b> <b>VALUE</b>	: Integer defining the number of meshes or faces that will be defined in the following. : Keyword followed by the value of the selected variable (area, volume or porosity) and the points to which this value applies
<b>volume</b> <b>or area</b> <b>or porosity</b>	: Real number equal to the selected variable value.
<b>i1</b> <b>...</b> <b>inpt</b>	: List of the <i>npt</i> points to be assigned: <ul style="list-style-type: none"> <li>- referring to scalar mesh numbering for volume or volume porosity variables</li> <li>- referring to vector node numbering in the selected direction for area or surface porosity variables</li> </ul>
<b>ZONE</b>	: Keyword indicating that for the mesh cells of a rectangular zone, the selected variable has the same value. This option may be repeated as many times as needed. It is followed by:
<b>zone_name</b> or <b>Ideb ifin</b> <b>jdeb jfin</b> <b>kdeb kfin</b> <b>volume</b> <b>or porosity</b>	: Name of a mesh zone previously defined in the MESH directive for the <i>elem</i> element. : six integers defining the scalar zone boundaries.
<b>FXZONE</b>	: Keyword indicating that the cell faces of a rectangular X vector zone have the same area or porosity. This option may be repeated as many times as needed. It is followed by:
<b>vx_zone_name</b>	: Name of a <i>vx_node</i> zone previously defined in the MESH directive for the <i>elem</i> element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 270/851

or

**ideb ifin** : six integers defining the X vector zone boundaries.

**jdeb jfin**

**kdeb kfin**

**area**

or **porosity**

**FYZONE** : Keyword indicating that the cell faces of a rectangular Y vector zone have the same area or porosity. This option may be repeated as many times as needed. It is followed by :

**vy\_zone\_name** : Name of a vy\_node zone previously defined in the MESH directive for the elem element.

or

**ideb ifin** : six integers defining the Y vector zone boundaries.

**jdeb jfin**

**kdeb kfin**

**area**

or **porosity**

**FZZONE** : Keyword indicating that the cell faces of a rectangular Z vector zone have the same area or porosity. This option may be repeated as many times as needed. It is followed by :

**vz\_zone\_name** : Name of a vz\_node zone previously defined in the MESH directive for the elem element.

or

**ideb ifin** : six integers defining the Z vector zone boundaries.

**jdeb jfin**

**kdeb kfin**

**area or porosity**

: real number equal to the selected variable value.

### Example

GEOM	PERC3D			
VOLUME	LISTVOL			
.0060264	.0029675	.0029675	.0029675	
.0029675	.0059351	.0029675	.0029675	
.0029675	.0029675	.0060264	.0059322	
.0029212	.0029212	.0029212	.0029212	
.0058424	.0029212	.0029212	.0029212	
.0029212	.0059322	.0060264	.0029675	
.0029675	.0029675	.0029675	.0059351	
.0029675	.0029675	.0029675	.0029675	
.0060264				
AREAEDGE	X	DEFAULT	0.0	
AREAEDGE	Y	DEFAULT	0.0	
LISTPOIN	4	VALUE	0.02787	
	12	22	23	33
LISTPOIN	2	VALUE	0.02745	

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 271/851

SEGMENT	13	17	28	
SEGMENT	18	16	VALUE	0.01373
SEGMENT	24	21	VALUE	0.01373
SEGMENT	29	27	VALUE	0.01373
AREAEDGE	Z	32	VALUE	0.01373
SEGMENT	13	Z	DEFAULT	.01141
		24	VALUE	.01131

;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 272/851

66

## GOBALLON DIRECTIVE

The **GOBALLON** directive, placed in *command block*, allows the calculation of the fuel ballooning in a reactor fuel or in a stand-alone fuel element.

It must be used after the steady-state computation and it is advised to use it after the control command (stabilized transient) performed to obtain the initial state.

Indeed, if the GOBALLON directive is used too early, during the stabilized transient, and especially if this transient is at high temperature, the thermo-mechanical calculation may lead to a high deformation of the cladding due to creep, whereas this deformation has no physical meaning for the stabilized transient.

### Associated Keywords

FUELCHAR

### Syntax

```
GOBALLON elem      r1      r2      r3
          (ALL)
or
          (FUEL)
;
```

<b>elem</b>	: name of a reactor or catafuel element.
<b>r1</b>	: non coplanarity coefficient for the NUREG model. Values to be used : 0.46D0 for a PWR reactor calculation or 0.56D0 for a standalone fuel calculation (CATHACOMB).
<b>r2</b>	: coefficient used to take into account undeformable fuelchars. Value to be used : 0.95D0
<b>r3</b>	: coefficient that is no longer used (value 1.0D0 for example)
<b>ALL/FUEL</b>	: OPTIONAL keyword to specify the kind of wall on which the ballooning is applied Default value is "FUEL".
<b>ALL</b>	: the ballooning model is applied on all the walls of the "elem" element. This keyword must be use only with electric fuel rods like in PERICLES experiments.
<b>FUEL</b>	: the ballooning model is applied only on the fuel walls. It must be use for PWR reactor.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 273/851

<b>Example</b>
----------------

```

RESTORE      ;
REACTOR     reacname      ;
PERMINIT    ...          ;
REALC       ...          ;
GOPERM      ;
```

Beginning of the stabilized transient block

...

End of the stabilized transient block

...

```

GOBALLON   reacname      r1           r2           r3
           ALL          ;
```

...

```

END        EXEC         ;
```

**NB:** The corresponding FORTRAN subroutine called in PILOT is GOFUEL : CALL GOBALLON (OBJNAM, r1, r2, r3, select\_wall, \*9999)

OBJNAM	CHARACTER*8 name of the reactor
select_wall	CHARACTER*8: keyword “ALL” or “FUEL”

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 274/851</a>

67

## GOBORA DIRECTIVE

The **GOBORA** directive starts a radio-chemical transport calculation in a circuit or modifies the nature of the related calculation in a circuit. It remains operative until the next GOBORA directive is applied to the same circuit.

### Remarks :

1. The non-mentioned variables in the radio-chemical transport calculation started by GOBORA are automatically set to zero.
2. In a radio-chemical transport calculation with SGTR, while the SGTR is opened, the related calculations in both circuits (primary and secondary) must be of the same nature.
3. In a radio-chemical transport calculation with a SOURCE (or a PIQREV, PIQBREK, PIQSOUP, PIQSEB, PIQ-VANNE not of the subtype NOREVERS), while the gadget is connected, the source injections must be compatible with the executed calculation.
4. This directive should be used after steady state calculation (GOPERM) for it is not available during initialization.

### Associated Keywords

ACTEMIS, SCRAM, WRIBA, VALBA, RADCHEMI, WCIRCB, ACCU, INIBORA, ZONBAMOY

### Syntax

```
GOBORA      circ1
or           reactor
;
;
```

<b>circ1</b> <b>reactor</b>	: circuit name : reactor name. In this case, the calculation will be made in all circuits belonging to the reactor. It is mandatory to use the reactor name in case of implicit exchanger between the two circuits of the reactor.
--------------------------------	---

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 275/851

<b>Example</b>
----------------

GOBORA      circ1 ;

**NB :** To accept input deck from previous versions of **CATHARE**, the obsolete keywords BOTH and NONE are still accepted but they do not have any action on calculation. Only INIBORA directive used with no arguments – to keep last calculated values - is able to stop calculation.

The corresponding FORTRAN subroutine called in PILOT is GOBORA : CALL GOBORA (OBJNAM, \*9999)

OBJNAM	CHARACTER*8 name of the circuit
*9999	fatal error treatment

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 276/851

# 68

## GODIFF DIRECTIVE

The **GODIFF** directive of *the command block* activates the diffusion model in the 3D hydraulics. It must be used after steady-state computation.

If the turbulent computation is activated, then the diffusion computation is automatically activated by the directive GO-TURB and it is not necessary to use the directive GODIFF.

### Associated Keywords

THREED, TURBULEN, GOTURB

### Syntax

**GODIFF**      **element**      ;

**element**      : name of a threed-type element

### Example

**GODIFF**      CANAL      ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 277/851

69

## GOFUEL DIRECTIVE

The **GOFUEL** directive, placed in *command block*, launches the thermo-mechanical calculation in a reactor fuel or in a stand-alone fuel element.

It must be used after the steady-state computation and it is advised to use it after the control command (stabilized transient) performed to obtain the initial state.

Indeed, if the GOFUEL directive is used too early, during the stabilized transient, and especially if this transient is at high temperature, the thermo-mechanical calculation may lead to a high deformation of the cladding due to creep, whereas this deformation has no physical meaning for the stabilized transient.

### Associated Keywords

FUELCHAR, CATAFUEL

### Syntax

**GOFUEL** elem ;

**elem** : name of a reactor or catafuel element.

### Example

```

RESTORE ;
REACTOR    reacname      ;
PERMITIT   ...          ;
REALC      ...          ;
...
GOPERM     ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 278/851

GOFUEL        reacname        ;  
...  
END            EXEC        ;

**NB:** The corresponding FORTRAN subroutine called in PILOT is GOFUEL : CALL GOFUEL (OBJNAM, \*9999)

OBJNAM        CHARACTER\*8 name of the reactor

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 279/851

70

## GONEUT DIRECTIVE

The **GONEUT** directive placed in the *command block*, launches the point kinetics calculation in a reactor. It must be used after the steady-state and the stabilized transient computation performed to obtain the thermal-hydraulic initial state.

### Associated Keywords

**CORE, SCRAM, ROROD, FUEL** (NEUTRO), **FUEL3D** (NEUTRO), **FUELCHAR** (NEUTRO), **XNEULIST**, **XNEULISX**

### Syntax

```
GONEUT core1 ( react1 ) ;
```

<b>core1</b>	: core name
<b>react1</b>	: OPTIONAL keyword used to specify if feedback anti-reactivity calculation should be performed. It may have the following values :
	REACT (default) : feedback anti-reactivity calculation is performed
	or NOREACT : no feedback anti-reactivity calculation is performed

### Example

1)

```
REACTOR RESTORE ;
PERMINIT reacname ;
REALC ... ;
GOPERM ... ;
END EXEC ;
```

2)

```
RESTORE ;
REACTOR reacname ;
PERMINIT ... ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 280/851

```

REALC      ...      ;
GOPERM     ;         

...
GONEUT    CORE1      NOREACT   ;
...
IF         (TIME      >        10.)      ;
           GONEUT    CORE1      REACT    ;
ENDIF      ;
END       EXEC      ;

```

**NB:** The corresponding FORTRAN subroutine called in PILOT is GONEUT.

 <b>ce<sub>a</sub></b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 281/851

71

## GOPERM DIRECTIVE

The **GOPERM** directive is used, in the *command block*, to trigger steady state computation of a reactor. Complete specifications for the desired steady state computation must appear before GOPERM (see **PERMITIT**, **REALC** etc...)

**N.B.** The results of the steady state computation will be printed systematically by the code.

### Associated Keywords

**PERMITIT**, **ROCOPELEM**, **ECHPOWER**, **IMPOSFLOW**, **LEVEL**, **NOFLOW**, **REALC**, **REALVO**, **REALAX**, **TPERTR**

### Syntax

**GOPERM** ;

**NB** : The corresponding FORTRAN subroutine called in PILOT is GOPERM : CALL GOPERM (LALIDENH, \*9999)

LALIDENH	INTEGER pointer of the head structure of the reactor. This value is an output of the REACTOR subroutine.
----------	--

DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b> SACLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 282/851

72

## GOTURB DIRECTIVE

The **GOTURB** directive of *the command block* performs the initialization and activates the turbulent k-ε model in 3D hydraulics. It must be used after steady-state computation.

The initial state is the one declared in the *data block* (refer to **TURBULEN** directive for 3D-modules).

### Associated Keywords

**THREED, GODIFF, TURBULEN**

### Syntax

**GOTURB**      element      ;

**element**      : name of a threed-type element

### Example

**GOTURB**      CANAL ;

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 283/851

73

## GUI\_DAT OPERATOR

The **GUI\_DAT operator**, in the *data block*, is used to improve compatibility between GUITHARE and **CATHARE**. GUITHARE stores data in **CATHARE** input deck enclosed between two markers as illustrated below. These data concern the graphic positioning of **CATHARE** thermohydraulic objects by GUITHARE and cannot be changed by the user. The two markers and the data are not interpreted by **CATHARE**.

### Associated Keywords

[GUI\\_DAT](#), [NEW\\_SYNT](#)

### Syntax

```
GUI_DAT      [           ;
  Data concerning the graphic positioning of CATHARE thermohydraulic
  objects added by GUITHARE
]           GUI_DAT      ;
;
```

### Example

```
GUI_DAT      [           ;
ENTREE      COORDS    -2.20195   1.5484;
SORTIE      COORDS    2.24216    2.43033      ;
]           GUI_DAT      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 284/851

74

## GVPOWER DIRECTIVE

The **GVPOWER** directive, compulsory if there is 0-dimensional secondary side steam generator, must be used after PERMIT in the *command block*, to initialize the power delivered by the steam generator.

### Associated Keywords

**SGCARACT, WALL** (POINTSG), **SGFEED**

### Syntax

```
GVPOWER pointsg_name
      ITERATE
      EXCHCOEF
        ( or
        or
        SGP
      FOULING
      PRESSURE )
      power
    ;
or
FEEDFLOW qliq
```

<b>pointsg_name</b>	: name of the pointsg element (defining with SGCARACT operator).
<b>ITERATE</b>	: keyword indicating that the code will iterate on, in order to balance the primary-secondary exchange under steady conditions. This is followed by :
<b>EXCHCOEF</b>	: keyword indicating that the code must iterate on the SECONDARY EXCHANGE COEFFICIENT;
or	
<b>FOULING</b>	: keyword indicating that the code must iterate on the FOULING;
or	
<b>PRESSURE</b>	: keyword indicating that the code must iterate on the SECONDARY PRESSURE;
<b>SGP power</b>	: keyword followed by a real number $\geq 0$ . initializing the power to be delivered by the steam generator (W);
or	
<b>FEEDFLOW qliq</b>	: keyword followed by a real number $\geq 0$ . indicating that the code will run with imposed feedwater flow (kg/s).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 285/851

<b>Example</b>
----------------

```

PERMINIT    ...      ;
*
LEVEL       ...      ;
*
NOFLOW      ...      ;
*
IMPOSFLOW   ...      ;
*
IMPOSFLOW   ...      ;
*
IMPOSFLOW   ...      ;
*
REALC       ...      ;
GVPPOWER    WALL8    ITERATE   EXCHCOEF  SGP        948.18D6    ;
GVPPOWER    WALLGR   ITERATE   PRESSURE   SGP        948.18D6    ;
...
GOPERM      ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 286/851

75

## HTCBACON DIRECTIVE

The **HTCBACON** directive, in *command block*, enables the user to use the Aconda law for convective vapor heat transfer enhancement in case of cladding rupture, for a specified fuelchar.  
It becomes effective when used.

### Associated Keywords

FUELCHAR, STOPACON

### Syntax

**HTCBACON**    fuelchar1            ;

**fuelchar1**            : name of the fuelchar element for which the model is going to be activated.

**NB1** : This directive impacts directly the **CATHARE** calculation.

### Example

HTCBACON    CARCHO            ;

**NB2** : the FORTRAN subroutine called in PILOT is HTCBACON: CALL HTCBACON ( OBJNAM, \*9999)

OBJNAM            CHARACTER\*8 name of the fuelchar for which the model is going to be activated

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 287/851

76

## HTCBYHL DIRECTIVE

The **HTCBYHL** directive, in *command block*, enables the user to use the Yao-Hochreiter-Leech law for convective vapor heat enhancement in case of cladding rupture, for a specified fuelchar.  
It becomes effective when called.

### Associated Keywords

FUELCHAR, STOPYHL

### Syntax

**HTCBYHL**      fuelchar1      ;

**fuelchar1**      : name of the fuelchar element for which the model is going to be activated

**NB1** : This directive impacts directly the **CATHARE** calculation.

### Example

HTCBYHL      CARCHO      ;

**NB2** : the FORTRAN subroutine called in PILOT is HTCBYHL: CALL HTCBYHL ( OBJNAM, \*9999)

OBJNAM      CHARACTER\*8 name of the fuelchar for which the model is going to be activated



77

## **HYDCHAN OPERATOR**

The **HYDCHAN** operator is used in the *data block* to define a one-dimensional hydraulic channel surrounding a wall (or a fuel wall) within a threeed element.

### **Associated Keywords**

## HYDIMP, STOREHYD, RESHCAT, CATAFUEL

## Syntax

hydnam = **HYDCHAN** wallnam ;

**hydnam** : name of the one dimensional hydraulic channel.  
**wallnam** : name of a fuelchar or of a wall3d element linked to the threed element.

## Example

HYDCA = HYDCHAN CARCA ;

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 289/851

78

## HYDIMP OPERATOR

The **HYDIMP** operator, used in *data block*, creates a hydimp element for one standalone fuel calculation. HYDIMP is the acronym used to name a kind of sub-axial element with HYdraulics IMPosed. This imposed hydraulics may be calculated by a previous **CATHARE** calculation and stored in a “**CATHARE** hydraulic file” or it may be defined by the user in an “external hydraulic file”.

### Associated Keywords

**CATAFUEL, COMPHYD, HYDMOD, READHCAT, READHEXT, STDYFUEL, TRANFUEL**

### Syntax

```
hydnam=      HYDIMP      axialnam      ;
or
hydnam=      HYDIMP      hydchana     ;
```

**hydnam** : name of the hydimp element to be defined.

**axialnam** : in case of a standalone fuel calculation performed from an external hydraulic file (see **CATAFUEL**, option 1), the word axialnam is necessary but not used.  
In case of a standalone fuel calculation performed from a **CATHARE** hydraulic file (see **CATAFUEL**, option 2) axialnam must correspond to the name of an AXIAL element saved by the **STOREHYD** directive.

**hydchana** : in case of a standalone fuel calculation performed from a **CATHARE** hydraulic file relative to a THREED element (see **CATAFUEL**, option 2), hydchana must correspond to the name of an hydchan element defined by the HYDCHAN operator and saved by the **STOREHYD** directive.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 290/851

<b>Example</b>
----------------

1. 1D example :

Assuming that the object *coeurmoy* has been defined as an AXIAL in a previous calculation and has been saved with the directive STOREHYD :

```
hydimp1 =      HYDIMP      coeurmoy      ;
```

2. 3D example :

Assuming that *chan*, *chanb* and *chanc* have been defined as HYDCHAN objects in a previous calculation and have been saved with the directive STOREHYD :

```
hydchan1 =      HYDIMP      chan       ;
hydchan2 =      HYDIMP      chanb      ;
hydchan3 =      HYDIMP      chanc      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 291/851

79

## HYDMOD DIRECTIVE

The **HYDMOD** directive is used in *command block* to change the 1D hydraulic attached to an hydimp element during a standalone fuel calculation.

### Associated Keywords

CATAFUEL, COMPHYD, HYDIMP, READHCAT, READHEXT, STDYFUEL, TRANFUEL

### Syntax

```
HYDMOD      hydnam      axialnam      ;
```

**hydnam** : name of the hydimp element.  
**axialnam** : axial name for which the hydraulics has been saved by STOREHYD directive.

### Example

#### Preliminary hydraulic calculation

```
coeurcho=      AXIAL ...      ;  

courmoy=       AXIAL ...      ;  

...  

END           DATA           ;  

STOREHYD     courmoy       coeurcho      ;
```

#### Standalone fuel calculation

```
...  

hydimp1=      HYDIMP       coeurcho      ;  

...
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 292/851

END DATA ;

...

\*\*\*\*\* Replace the fuelchar coeurcho by courmoy \*\*\*\*\*

HYDMOD hydimp1 courmoy ;

**N.B.** : The hydraulics (here courmoy and coeurcho) must have been saved by the same preliminary hydraulic calculation in the same **CATHARE** hydraulic file.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 293/851

# 80

## HYDRCOM DIRECTIVE

The **HYDRCOM** directive, used in *data block*, allows choosing calculation options for the wall friction coefficients in an element of axial type or all the axial elements of a circuit.

This directive must be used after the MESH directive.

This directive can be used several times on the same element.

The **HYDRCOM** directive can be used to modify calculation options during a transient, in *command block*.

### Associated Keywords

**HYDRMOD**, **AXIAL**, **MESH**, **COMETE**

### Syntax

<b>HYDRCOM</b>	<b>elemnam</b>							
	<b>ROUGH</b>	<b>(SEGMENT</b>	<b>Pi</b>	<b>Pj)</b>	<b>VALUE</b>	<b>r</b>		;
<b>or</b>	<b>FROTFILM</b>	<b>ON</b>	or	<b>OFF</b>	;			
<b>or</b>	<b>STRATIF</b>	<b>ON</b>	or	<b>OFF</b>	;			

<b>elemnam</b>	: name of the element (circuit, axial element or tee-branch). If the element is a circuit, all the axial elements of the circuit are modified.
<b>ROUGH</b>	: keyword to indicate that rough value is to be defined.
<b>SEGMENT</b>	: optional keyword to read a segment on which rough is to be defined. This keyword can not be associated to a circuit.
<b>Pi Pj</b>	: points belonging to the axial element and which define the beginning and the end of the segment.
<b>VALUE r</b>	: keyword followed by a real r, r is the rough value (m). Default value is $10^{-6}$ m
<b>FROTFILM</b>	: keyword to indicate that friction coefficient for the film will be calculated (ON) or not (OFF). By default the option is OFF.
<b>STRATIF</b>	: keyword to indicate that the stratification will be taken into account (ON) or not (OFF). By default the option is OFF.

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 294/851

<b>Example</b>
----------------

...  
HYDRCOM CIRCP ROUGH VALUE 3.D-6 ;  
HYDRCOM Branche1 ROUGH SEGMENT PB03 PB08  
HYDRCOM VALUE 1.5D-6 ;  
HYDRCOM Branche1 FROTFILM ON ;  
...  
...

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 295/851

# 81

## HYDR DIRECTIVE

The **HYDR** directive (*data block*) allows mainly to specify the characteristics of the hydraulic geometry:

1. For AXIAL or THREED types it assigns a hydraulic geometry to a specified region of the mesh
2. For AXIAL element only, it can also select the numerical scheme (1<sup>st</sup> or 2<sup>nd</sup> order accuracy) used for solving radio-chemical transport

### 81.1 Hydraulic geometry of a 1-D element

This directive must be used after the MESH directive.

The default option for the “primary-type” is standard (cylindrical) PIPE-type geometry.

This directive can be used several times on the same element. Then, for the “primary-type”, user specified axial intervals of the pipe can receive appropriate hydraulic geometry properties. For the “primary-type”, if intervals are overlapping, the property is overwritten on the meshing by each successive directive.

#### Associated Keywords

AXIAL, GEOM, MESH, SINGULAR, WALL, FUELPLAQ, RJH, NP

#### Syntax

```

HYDR      element      primary-type    (x1 x2)
              (           RJHCHANL   or          PNCHANL
              (           scheme       (           value        )
              ;           ;           )           )

```

<b>element</b>	: AXIAL element name
<b>primary-type</b>	: one of the following keywords :
<b>RODBUNDL</b>	: rodbundle geometry (i.e. reactor core region)
<b>ANNULAR</b>	: annular geometry (i.e. reactor vessel downcomer)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 296/851

**x1 x2** : OPTIONAL real numbers > 0. giving the elevations of the first and last points where the primary-type is assigned to the hydraulic geometry.  
*(By default the HYDR primary-type is applied to the whole element)*

**RJHCHANL** or **PNCHANL** : OPTIONAL keyword to indicate that the user applies to this hydraulic element the physical closure relationships of the **RJH** (Jules Horowitz Reactor) or of the **NP** (Nuclear Propulsion) private libraries.

**Remark:** To use this model, the user must associate a corresponding WALL(s) (Standard or FUELPLAQ) to this axial hydraulic element and verify that:

The **RJH/NP** walls span the total length of the hydraulic element,  
For each hydraulic mesh, there is a single **RJH/NP** elementary wall

**scheme** : one of the following keywords :

**UPWIND** 1<sup>st</sup> order upwind donor cell (default scheme)

or

**IMAPE (fr\_imape)** 2<sup>nd</sup> order slant scheme with optional weight factor **fr\_imape** accessible to user specification

**fr\_imape** valid range is [0.0 – 0.5] ; 0.0 degenerates to standard UPWIND, 0.5 is the stability limit for this scheme.

This option is only applied to the internal meshes of the pipe (first and last meshes are always treated as 1<sup>st</sup> order upwind)

**Recommended choice :** If the **fr\_imape** value is not given by the user, by default the code performs a mesh by mesh automatic adjustment of the weight factor aimed to prevent spurious oscillations.

or

**VANLEER** 2<sup>nd</sup> order Van Leer explicit flux correction (MUSCL)

**Warning :** 2<sup>nd</sup> order accuracy is obtained only if CFL criterion is satisfied

### Examples

```

HYDR      midcore    RODBUNDL          ;
or
HYDR      midcore    RODBUNDL  0.44    3.22 ;
or
HYDR      midcore    RODBUNDL          0.44    3.22 ;
HYDR      midcore    RJHCHANL          ;
or
HYDR      midcore    RODBUNDL  RJHCHANL  ;
or
HYDR      midcore    RODBUNDL          UPWIND   ;
or
HYDR      midcore    RODBUNDL          0.44    3.22
                                IMAPE    0.50    ;
or
HYDR      midcore    RODBUNDL          ;
HYDR      midcore    VANLEER           ;

```

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 297/851</a>

## 81.2 Hydraulic geometry of a 3-D element

Used after the **MESH** operator, the **HYDR** operator applied to a threed element enables the definition of the nature of the flow in the hydraulic meshes of the element.

This operator is **compulsory** in the definition of a **threed** module and must appear in the *data block*.

**NB :** For all information about numbering, please refer to user manual appendix “NUMBERING in THREED elements”

### Associated Keywords

THREED, CONNECT, GEOM, MESH, PHYSCALE, SINGULAR

### Syntax

**HYDR** elem

*Nature of the flow for the scalar correlations*

**SCAGRID**

and	<b>DEFAULT</b>	nflow	
	<b>SEGMENT</b>	begpt	endpt
		<b>VALUE</b>	nflow
or	<b>LISTPOIN</b>	npt	
		<b>VALUE</b>	nflow
		pt1	...
	<b>ZONE</b>	znam	nflow
	or	ibeg	iend
		jbeg	jend
		kbeg	kend
		nflow	

To be repeated  
as many times as  
needed

*Nature of the flow for the vector correlations*

**VECGRID**

and	<b>X</b>	(or	<b>TETA)</b>
	<b>DEFAULT</b>	nflow	
	<b>SEGMENT</b>	begpt	endpt
		<b>VALUE</b>	nflow
or	<b>LISTPOIN</b>	npt	
		<b>VALUE</b>	nflow
		pt1	...
	<b>FXZONE</b>	znam	nflow
	or	ibeg	iend
		jbeg	jend
		kbeg	kend
		nflow	

To be repeated  
as many times as  
needed

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 298/851</a>

#### VECGRID

	<b>Y</b>	(or	<b>R)</b>	
and	<b>DEFAULT SEGMENT</b>	nflow begpt <b>VALUE</b>	endpt nflow	
or	<b>LISTPOINT</b>	npt <b>VALUE</b>	nflow	
or	<b>FYZONE</b>	pt1 ... znam ibeg jbeg kbeg nflow	pti nflow iend jend kend	
	or			

To be repeated  
as many times as  
needed

#### VECGRID

	<b>Z</b>	(or	<b>TETA</b> )	
and	<b>DEFAULT SEGMENT</b>	nflow begpt <b>VALUE</b>	endpt nflow	
or	<b>LISTPOINT</b>	npt <b>VALUE</b>	nflow	
or	<b>FZZONE</b>	pt1 ... znam ibeg jbeg kbeg nflow	pti nflow iend jend kend	
	or			

To be repeated  
as many times as  
needed

*Nature of the flow in case of an annular DOWNCOMER*

#### VECGRID

	<b>X</b>	(or	<b>TETA</b> )	
and	<b>DEFAULT SEGMENT</b>	nflow begpt <b>VALUE</b>	endpt nflow	
or	<b>LISTPOINT</b>	npt <b>VALUE</b>	nflow	
or	<b>FXZONE</b>	pt1 ... znam ibeg jbeg kbeg nflow	pti nflow iend jend kend	
	or			

To be repeated  
as many times as  
needed

#### VECGRID

<b>Y</b>	(or	<b>R)</b>
<b>DEFAULT</b>	nflow	

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 299/851</a>

and <b>SEGMENT</b> begpt            endpt or <b>LISTPOIN</b> VALUE            nflow npt <b>VALUE</b> nflow pt1                ...                pti or <b>FYZONE</b> znam            nflow or                ibeg            iend jbeg            jend            kend kbeg            kend nflow	<b>To be repeated as many times as needed</b>
---	---

<b>VECGRID</b> <b>Z</b> <b>DEFAULT</b> and <b>SEGMENT</b> nflow begpt            endpt <b>VALUE</b> nflow or <b>LISTPOIN</b> npt <b>VALUE</b> nflow pt1                ...                pti or <b>FZZONE</b> znam            nflow or                ibeg            iend jbeg            jend            kend kbeg            kend nflow	<b>To be repeated as many times as needed</b>
--	---

;

**HYDR elem** : operator to define the nature of the flow for the scalar correlations (SCAGRID), for the vector correlations (VECGRID) and for an annular downcomer (DCOGRID).

**SCAGRID** It is followed by the three element name  
 : keyword to define the nature of the flow considered for the mass and energy balance equations correlations.

**DEFAULT** *nflow* : keyword followed by an integer *nflow* defining the nature of the flow for all the mesh cells :  
 0 → standard flow, fluid cell (generally) without internal structure  
 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type  
*If necessary, this can be followed by SEGMENT and/or LISTPOIN and/or ZONE (this optional part being repeated as many times as needed).*

**SEGMENT** : keyword to indicate that for all the mesh cell numbers between begpt and endpt (referring to scalar meshes numbering), the nature of the flow is defined by the VALUE *nflow* .

**begpt** : number of the first scalar mesh cell to be considered.  
**endpt** : last scalar mesh number to be considered.

Then all the mesh cell numbers between begpt and endpt are taken into account.

**and/or**

**VALUE** *nflow* : keyword followed by an integer defining the nature of the flow:  
 0 → standard flow, fluid cell (generally) without internal structure  
 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 300/851

<b>LISTPOIN</b>	: keyword indicating that, for a certain number of mesh cells, the nature of the flow is defined by the VALUE nflow.
<b>npt</b>	: number of mesh cells taken into account.
<b>VALUE nflow</b>	: keyword followed by an integer defining the nature of the flow: 0 → standard flow, fluid cell (generally) without internal structure 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type
<b>and/or</b>	
<b>pt1 ...pti</b>	: number values (referring to scalar meshes numbering) of the mesh cells taken into account.
<b>ZONE</b>	Keyword indicating that the cell meshes of a rectangular zone have the same flow type. This option may be repeated as many times as needed. It is followed by :
<b>zname</b>	Name of a mesh zone previously defined in the MESH directive for the elem element
<b>or</b>	
<b>ibeg iend</b>	six integers defining the scalar zone boundaries
<b>jdeb jend</b>	
<b>kbeg kend</b>	
<b>nflow</b>	Integer defining the nature of the flow for the considered scalar nodes. This integer can be set to different values : 0 → standard flow, fluid cell without internal structure, 1 → rod bundle flow, fluid cell with internal structure of rod bundle type
<b>VECGRID</b>	: keyword to define the nature of the flow considered for the momentum equations correlations. It has to be repeated for every direction.
<b>X</b>	rectangular coordinates
<b>Y</b>	: keyword indicating the X direction.
<b>Z</b>	: keyword indicating the Y direction.
<b>TETA</b>	: keyword indicating the Z direction.
<b>R</b>	cylindrical coordinates:
<b>Z</b>	: keyword indicating the TETA direction.
<b>DEFAULT nflow</b>	: keyword followed by an integer defining the nature of the flow for all the mesh cell faces: 0 → standard flow, fluid cell (generally) without internal structure 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type <i>If necessary, this can be followed by SEGMENT and/or LISTPOIN and/or FXZONE (or FYZONE or FZZONE) (this optional part being repeated as many times as needed).</i>
<b>SEGMENT</b>	: keyword to indicate that for all the mesh cell numbers between begpt and endpt (referring to vector numbering in the selected direction), the nature of the flow is defined by the VALUE nflow.
<b>begpt</b>	: number of the first vector node in the selected direction to be considered.
<b>nedpt</b>	: number of the last vector node in the selected direction to be considered.
	Then all the vector nodes which numbers are between begpt and endpt are taken into account.
<b>and/or</b>	
<b>VALUE nflow</b>	: keyword followed by a integer defining the nature of the flow : 0 → standard flow, fluid cell (generally) without internal structure 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type
<b>LISTPOIN</b>	: keyword indicating that for a certain number of mesh cell faces, the nature of the flow is defined by the VALUE nflow .

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 301/851

npt	: number of mesh cell faces taken into account.
<b>VALUE nflow</b>	: keyword followed by a integer defining the nature of the flow : 0 → standard flow, fluid cell (generally) without internal structure 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type
and/or	
pt1 ...pti	: numbers of the mesh cell faces taken into account, referring to the vector node numbering in the selected direction
<b>FXZONE or FY-ZONE or FZZONE</b>	keyword indicating that the VX (VY or VZ) nodes of a rectangular X vector zone (Y vector zone or Z vector zone ) have the same flow type. This option may be repeated as many times as needed. It is followed by :
or	
zname	name of a X vector zone (Y vector zone or Z vector zone ) previously defined in the MESH directive for the <i>elem</i> element
ibeg iend	six integers for velocity plane numbers defining zone boundaries
jdeb jend	
kbeg kend	
nflow	integer defining the nature of the flow for the considered nodes. This integer can be set to different values : 0 → standard flow, fluid cell (generally) without internal structure 1 → rod bundle flow, fluid cell (generally) with internal structure of rod bundle type
<b>DCOGRID</b>	: OPTIONAL keyword to impose specific correlations and discretization for an annular downcomer.
<b>X</b>	rectangular coordinates: : keyword indicating the X direction.
<b>Y</b>	: keyword indicating the Y direction.
<b>Z</b>	: keyword indicating the Z direction.
<b>TETA</b>	cylindrical coordinates: : keyword indicating the TETA direction.
<b>R</b>	: keyword indicating the R direction.
<b>Z</b>	: keyword indicating the Z direction.
<b>DEFAULT nflow</b>	: keyword followed by a integer defining the nature of the flow for all the mesh cells: 0 → standard flow 1 → specific correlations and discretization recommended for an annular downcomer <i>If necessary, this can be followed by SEGMENT and/or LISTPOIN and/or FXZONE (or FYZONE or FZZONE)(this optional part being repeated as many time as needed).</i>
<b>SEGMENT</b>	: keyword to indicate that for all the mesh cell numbers between begpt and endpt (referring to vector numbering in the selected direction), the nature of the flow is defined by the VALUE nflow.
begpt	: number of the first vector node in the selected direction to be considered.
nedpt	: number of the last vector node in the selected direction to be considered. Then all the vector nodes which numbers are between begpt and endpt are taken into account.
and/or	
<b>VALUE nflow</b>	: keyword followed by an integer defining the nature of the flow for all the mesh cells: 0 → standard flow 1 → specific correlations and discretization recommended for an annular downcomer
<b>LISTPOIN</b>	: keyword indicating that for a certain number of mesh cells, the nature of the flow is defined by the VALUE nflow.
npt	: number of mesh cells taken into account.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 302/851

**VALUE nflow** : keyword followed by a integer defining the nature of the flow for all the mesh cells:  
 0 → standard flow  
 1 → specific correlations and discretization recommended for an annular downcomer

and/or  
**pt1 ... pt1** : list of mesh cell numbers taken into account, referring to the vector node numbering in the selected direction

**FXZONE or FYZONE or FZZONE** keyword indicating that the VX (VY or VZ) nodes of a rectangular X vector zone (Y vector zone or Z vector zone ) have the same flow type. This option may be repeated as many times as needed. It is followed by :

**zname** name of a X vector zone (Y vector zone or Z vector zone) previously defined in the MESH directive for the elem element

**ibeg iend** six integers for velocity plane numbers defining zone boundaries

**jdeb jend**

**kbeg kend**

**nflow** integer defining the nature of the flow for the considered nodes. This integer can be set to different values :  
 0 → standard flow  
 1 → specific correlations and discretization recommended for an annular downcomer

### Example

#### **HYDR CUVE**

\* nature of the flow for the scalar grids (scalar nodes), standard flow everywhere except in the core where it is.  
 \* rod bundle

SCAGRID	DEFAULT	0		
	ZONE	HYCO	1	

\* nature of the flow for the vector grids (vector nodes), standard flow everywhere except in the core where it is  
 \* rod bundle

VECGRID	TETA	DEFAULT	0	
		FXZONE	HYXCO	1
VECGRID	R	DEFAULT	0	
		FYZONE	HYYCO	1
VECGRID	Z	DEFAULT	0	
		FZZONE	HYZCO	1

\* nature of the flow for annular downcomer (0: standard flow; 1: specific correlations and discretization)

DCOGRID	TETA	DEFAULT	0	
		FXZONE	HYXDC	1
DCOGRID	R	DEFAULT	0	
		FYZONE	HYYDC	1
DCOGRID	Z	DEFAULT	0	
		FZZONE	HYZDC	1
				;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 303/851

82

## HYDRMOD DIRECTIVE

The **HYDRMOD** directive is used in *command block* to change the calculation options for the wall friction (friction coefficient, stratification) attached to an axial element.

### Associated Keywords

**HYDRCOM, AXIAL, MESH, COMETE**

### Syntax

```

HYDRMOD elemnam
      FROTFILM (SEGMENT Pi Pj)
      ON or OFF ;
or      STRATIF (SEGMENT Pi Pj)
      ON or OFF ;

```

<b>elemnam</b>	: name of the element (circuit or axial element). If the element is a circuit, all the axial elements of the circuit are modified.
<b>FROTFILM</b>	: keyword to indicate that friction coefficient for the film will be calculated (ON) or not (OFF). By default the option is OFF.
<b>STRATIF</b>	: keyword to indicate that the stratification will be taken into account (ON) or not (OFF). By default the option is OFF.
<b>SEGMENT</b>	: optional keyword to read a segment on which modification is applied. This keyword can not be associated to a circuit.
<b>Pi Pj</b>	: points belonging to the axial element and which define the beginning and the end of the segment.

### Example

```

...
HYDRMOD Branche1 STRATIF OFF ;
...
HYDRMOD Branche1 FROTFILM
      SEGMENT PB03 PB08 ON ;

```

 <p>DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b>  SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/  RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 304/851

# 83

## IF DIRECTIVE

The **IF** directive is used for conditional execution of commands in the *command block* only.

### Associated Keywords

REPEAT, END, ENDIF, ELSE, QUIT, AND, OR

### Syntax

```
IF           condition      ;
...
ENDIF        ;
```

### Example

```
IF           (time      >      tmax)      ;
QUIT
block1      ;
;
ENDIF        ;
```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 305/851</a>

84

## IMPOSFLOW DIRECTIVE

The **IMPOSFLOW** directive is used after PERMINIT, in *command block*, to impose the flow distribution coefficients at outgoing junctions of an element during steady state computation. By default the flow distribution is calculated from the ratio of the outflow sections of the element.

For a given element the sum of the coefficients must be equal to 1. (precision  $10^{-6}$ ).

### Associated Keywords

**ECHPOWER, GOPERM, LEVEL, NOFLOW, PERMINIT, REALC, REALVO, REALAX**

### Syntax

```
IMPOSFLOW elem1
          junc1      coef1
...
          junen      coefn ;
```

<b>elem1</b>	: name of the element for which the flow coefficients are to be redefined. For each outflow junction of the element, the following are written :
<b>junci</b>	: name of the junction “i”,
<b>coefi</b>	: corresponding coefficient.

### Example

Assuming that volinf is a volume element connected to 2 axial elements bypassinf and moyinf :

```
IMPOSFLOW  volinf      bypassinf    0.0469109
           moyinf       0.9530891    ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 306/851

Refer to PERMINIT operator for a global initialization example.

**NB :** The corresponding FORTRAN subroutine called in PILOT is IMPOSFL. The arguments are the following ones :  
CALL IMPOSFL ( OBJNAM, CVAL, RVAL, NVAL, \*9999)

OBJNAM	CHARACTER*8 name of the element where flowrate distribution is imposed
CVAL	CHARACTER*8 array of junction names
RVAL	DOUBLE PRECISION array of distribution coefficient values
NVAL	INTEGER length of arrays CVAL and RVAL

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 307/851</a>

85

## IMPOSXI DIRECTIVE

The **IMPOSXI** directive is used after PERMIT, in the *command block*, to impose the value of the non-condensable gas fractions in a volume element during the steady state computation.

The number of non-condensable gas specified must be equal to the number of non-condensable gas in the circuit.

The value of the non-condensable gas fraction must be specified in each sub-volume (INF and SUP).

### Associated Keywords

**GOPERM, IMPOSFLOW, NOFLOW, LEVEL, PERMIT, REALC, VOLUME**

### Syntax

```
IMPOSXI elem1
          X1INF      coeff1inf    X1SUP      coeff1sup
          (X2INF     coeff2inf    X2SUP     coeff2sup)
...
;
```

<b>elem1</b>	: name of the volume element
<b>XiINF coeff1inf</b>	: keyword followed by a real number (ith non-condensable gas fraction in the lower sub-volume)
<b>XiSUP coeff1sup</b>	: keyword followed by a real number (ith non-condensable gas fraction in the upper sub-volume)

### Example

Assuming that VOL is a volume element:

```
IMPOSXI   VOL
          X1INF      0.63       X1SUP      0.99
;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 308/851

Refer to PERMINIT operator for a global initialization example.

**NB :** The corresponding FORTRAN subroutine called in PILOT is IMPOSXI. The arguments are the following ones :  
 CALL IMPOSXI ( OBJNAM, CVAL, RVAL, NVAL, \*9999)

OBJNAM	CHARACTER*8 name of the element where the non-condensable gas fractions are imposed
CVAL	CHARACTER*8 array of the directive keyword names (i.e. in the example [X1INF, X1SUP])
RVAL	DOUBLE PRECISION array of values specified in the directive (i.e. in the example [0.63, 0.99])
NVAL	INTEGER length of arrays CVAL and RVAL

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 309/851

86

## IMPRIME DIRECTIVE

The **IMPRIME** directive is used, in *command block*, after a TRANSIENT statement to force printouts of all the circuits and their elements, with no consideration to the current PERIOD specifications.

### Associated Keywords

RESULT, PERIOD, LIST, MESSAGE, PRIN3D, SAVE, TITLE

### Syntax

**IMPRIME** (object\_name) ;

**object\_name** : OPTIONAL name of an element of the reactor, or the name of the reactor itself (default value is the name of the reactor). The definition is mandatory in case of several reactors or in a fuel stand-alone input deck.

**NB** : The corresponding FORTRAN subroutine called in PILOT is IMPRIM : IMPRIM (OBJNAM, \*9999)

OBJNAM Name of an element of the reactor or name of the reactor itself

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 310/851

87

## INIBIL DIRECTIVE

The **INIBIL** directive is used, in *command block*, to **initialize** or reinitialize balance report in the whole reactor, in a particular circuit or in a zone during a calculation : WATER mass, non-condensable gas mass , RADIOCHEMICAL components mass and energy balances.

### Associated Keywords

BILAN3D, ZONE

### Syntax

**INIBIL**      object\_name      ;

**object\_name**      : reactor, circuit or zone name

**NB** : The corresponding FORTRAN subroutine called in PILOT is INIBIL. The arguments are the following ones : CALL INIBIL ( OBJNAM, \*9999)

OBJNAM      CHARACTER\*8 name of the reactor or of a circuit or of a zone

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 311/851

88

## INIBORA DIRECTIVE

The **INIBORA** directive is used, in *command block*, to initialize or reinitialize for a radio-chemical component, its concentration in a circuit or in a zone. It can also be used to reinitialize these data during a calculation. In that case the unmentioned variables are not modified (it is then a way to stop radio-chemical transport calculation). With the INIBORA directive, data can be given to describe a clad rupture. The clad rupture will be simulated by using the directive WRIBA.

### Associated Keywords

ACTEMIS, SCRAM, WRIBA, VALBA, RADCHEMI, WCIRCB, ACCU, GOBORA, ZONBAMOY

### Syntax

<b>INIBORA</b>	obj1	<b>COMPONENT</b>	compname			
(		<b>ELEM</b>	<b>CONCENL</b>	cle	<b>CONCENG</b>	cge
(			elem1			
(			<b>CONCENL</b>	cle	<b>CONCENG</b>	cge)
(			<b>XCOTE</b>		xc	
or			<b>XCOTPC</b>		xpc	
(			<b>XRUPPT</b>		xr	
(			<b>DTRUPT</b>		dr	)
(			<b>NFUEL</b>	nfuel		
			<b>XCOTE3D</b>	Fuelchar1	xc1	
				....	....	
				Fuelcharrn	xcn	
or			<b>XCOTPC3D</b>	Fuelchar1	xpc1	
				....	....	
				Fuelcharrn	xpcn	
			<b>XRUPPT3D</b>	Fuelchar1	xr1	
				....	....	
			<b>DTRUPT3D</b>	Fuelchar1	xrn	
				....	dr1	
				Fuelcharrn	drn	)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 312/851

```

(      DEGASA    nmdeg   mesch1   rdega1
      ....      meschn   ....
      ....      mesch1   Rdegan )
(      DISSOL    nmdis    mesch1   rdiss1
      ....      meschn   ....
      ....      mesch1   rdissn )
(      CONDEN    nmcon    mesch1   rcon1
      ....      meschn   ....
      ....      mesch1   rconn )
(      EVAPOR    nmeva   mesch1   reva1
      ....      neschn   ....
      ....      revan )) )
(      ELEM      elem2    GROUP    TEMPLATE elem1)
(      ELEM      elemn
      ....
      );

```

- obj1** : name of the object. It must be a circuit or a zone but cannot be a reactor.  
All the elements of the object will be concerned.
- COMPONENT compname** : keyword followed by the name of the radio-chemical component.
- CONCENL cle** : real number  $\geq 0$ . defining the initial radio-chemical concentration in the liquid phase in the object. The default value is 0. at the first initialization.
- CONCENG cge** : real number  $\geq 0$ . defining the initial radio-chemical concentration in the gas phase in the object. The default value is 0. at the first initialization.
- ELEM elem1** : OPTIONAL keyword followed by the name list of elements in the object obj1 for which the concentration will be given and will be different from the initial value of the radio-chemical concentration in the object. This sequence may be repeated for as many element as needed
- CONCENL cle** : OPTIONAL real number  $\geq 0$ . defining the new radio-chemical concentration in the liquid phase in this element in GBq/kg for radio-active elements, kg of chemical components / kg of gas for chemical components.
- CONCENG cge** : OPTIONAL real number  $\geq 0$ . defining the new radio-chemical concentration in the gas phase in this element in GBq/kg for radio-active elements, and kg of chemical components / kg of liquid for chemical components.
- The following data allow the simulation of a clad rupture of the fuel rod in case of an axial element :
- XCOTE xc** : OPTIONAL keyword followed by a real number  $\geq 0$ . defining the height (m) of the fuel rod part where the clad rupture occurs.
- XCOTPC xpc** : OPTIONAL keyword followed by a real number in percentage ( $0 \leq xpc \leq 1$ ), defining the height of the rod part where the rupture appears, comparing to the height of the rod.
- XRUPT xr** : OPTIONAL keyword followed by a real number  $\geq 0$ . representing the number of ruptured rods.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 313/851

<b>DTRUPT dr</b>	: OPTIONAL keyword followed by a real number $\geq 0$ . representing the period of time(s) during which the rupture occurs.
<b>ELEM elem2</b>	<u>If an axial element is of type GROUP:</u> : Name of an <b>AXIAL GROUP</b> element followed by the keyword GROUP.
<b>GROUP</b>	
<b>TEMPLATE elem1</b>	: Keyword followed by the axial element name elem1 previously defined in the INI-BORA directive. This operator will duplicate the concentration and/or the data of the clad rupture of the elem1 axial element for the elem2 axial element, as many times as the number of duplicated axial element contained in the AXIAL GROUP element.
	The following data allow the simulation of a clad rupture of the fuel rod in case of a threed element :
<b>NFUEL nfuel</b>	: OPTIONAL keyword followed by integer $\geq 0$ , representing the number of Fuelchar objects.
<b>XCOTE3D</b> Fuelchar1 xc1	: OPTIONAL keyword followed by a fuelchar name and a real number $\geq 0$ defining the height (m) of the fuel rod part where the clad rupture occurs.
....	
Fuelcharn xcn	
<b>XCOTPC3D</b> Fuelchar1 xcp1	: OPTIONAL keyword followed by a fuelchar name and a relative real number ( $0 \leq xcp \leq 1$ ), defining the height of the rod part where the rupture appears, comparing to the height of the rod.
....	
Fuelcharn xcpn	
<b>XRUPT3D</b> Fuelchar1 xr1	: OPTIONAL keyword followed by a fuelchar name and a real number $\geq 0$ , representing the number of ruptured rods.
...	
Fuelcharn xrn	
<b>DTRUPT3D</b> Fuelchar1 dr1	: OPTIONAL keyword followed by a fuelchar name and a real number $\geq 0$ , representing the period of time(s) during which the rupture occurs.
...	
Fuelcharn drn	
	The following data allow the change of degassing, dissolution, condensation or evaporation constant :
<b>DEGASA</b>	: OPTIONAL keyword followed by :
nmdeg	- nmdeg : number of meshes where degassing time constant has to be changed.
mesch1 rdegal	- mesh number list (meschi, integer $\geq 0$ ) and the corresponding degassing time constant list (rdegal, real number $\geq 0$ ) (s).
....	
meschn rdegan	
<b>DISSOL</b>	: OPTIONAL keyword followed by :
nmdis	- nmdis : number of meshes where dissolution time constant has to be changed.
mesch1 rdiss1	- mesh number list (meschi, integer $\geq 0$ ) and the corresponding dissolution time constant list (rdissi, real number $\geq 0$ ) (s).
....	
meschn rdissn	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 314/851

<b>CONDEN</b>	: OPTIONAL keyword followed by :
nmcon	- nmcon : number of meshes where entrainment coefficient due to condensation has to be changed.
mesch1 rcon1	- mesh number list (meschi, integer $\geq 0$ ) and the corresponding entrainment coefficient due to condensation list (rconi, real number $\geq 0$ ).
....	
meschn rcomm	
<b>EVAPOR</b>	: OPTIONAL keyword followed by :
nmeva	- nmeva : number of meshes where entrainment coefficient due to evaporation has to be changed.
mesch1 reva1	- mesh number list (rmeschi, integer $\geq 0$ ) and the corresponding entrainment coefficient due to evaporation list (revai, real number $\geq 0$ ).
....	
meschn revan	

### Example

#### HPLUS + AZOTE16 - primary circuit (with simulation of clad rupture for a standard element)

```

INIBORA    circ1      COMPONEN   HPLUS
           CONCENL    6.31D-8     CONCENG   0.0D0
ELEM       elem1      XCOTE      2.2
           XRUPT      33.0
           DTRUPT     2.5
INIBORA    circ1      COMPONEN   AZOTE16
           CONCENL    0.0D0      CONCENG   0.0D0      ;
GOBORA     CIRC1      ;
```

#### BORON + COMPO03 - primary circuit

```

INIBORA    circ1      COMPONEN   BORON
           CONCENL    6.31D-8     CONCENG   0.0D0 ;
INIBORA    circ1      COMPONEN   COMPO03
           CONCENL    0.0D0      CONCENG   0.0D0
ELEM       coeurmoy   CONCENL    2.0D-1     CONCENG   0.0D0 ;
GOBORA     circ1      ;
```

#### HPLUS + AZOTE16 - primary circuit (with simulation of clad rupture for a standard element and an element of type GROUP)

```

INIBORA    circ1      COMPONEN   HPLUS
           CONCENL    6.31D-8     CONCENG   0.0D0
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 315/851

```

ELEM      elem1
          XCOTE    2.2
          XRUPT   33.0
          DTRUPT   2.5
ELEM      elem2
INIBORA   circ1
          GROUP    TEMPLATE elem1 ;
          COMPONEN AZOTE16
          CONCENL  0.0D0   CONCENG  0.0D0   ;
GOBORA    CIRC1   ;

```

### THREED CASE

```

INIBORA   circ1
          COMPONEN BORON
          CONCENL  6.31D-8   CONCENG  0.0D0
ELEM      coeurmoy
          NFUEL    2
          XCOTE3D Fuelchar1 xc1
          XRUPT3D Fuelchar1 xr1
          DTRUPT3D Fuelchar1 dr1
GOBORA    circ1   ;

```

### REINITIALIZATION OF DEGASING AND EVAPORATION CONSTANTS

```

INIBORA   circ1
          COMPONEN BORON
          CONCENL  6.31D-8   CONCENG  0.0D0
ELEM      coeurmoy
          DEGASA 2 1 1.D5
          EVAPOR 3 3 0.3D0   2 2.D5
          circ1   ;           4 0.4D0   5 0.5D0 ;
GOBORA    ;

```

### BORON + XENON133 – in the zone ZONE1

```

INIBORA   zone1
          COMPONEN BORON
          CONCENL  6.31D-8   CONCENG  0.0D0 ;
INIBORA   zone1
          COMPONEN XENON133
          CONCENL  0.0D0   CONCENG  0.0D0
ELEM      coeurmoy
          CONCENL  2.0D-1   CONCENG  0.0D0 ;

```

**NB :** The corresponding FORTRAN subroutine called in PILOT is INIBORA. It will be called once for the circuit and eventually followed by as many calls as they are elements to initialize : CALL INIBORA ( IPASS, RNFUEL, RNDEGA, RNDIIS, RNCOND, RNEVAP, RTABC, RTABI, RTABR, \*99999)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 316/851

IPASS	Integer (=1 for a circuit, =2 for an element)
RNFUEL	Integer, number of fuelchar object (can be $\neq 0$ in case of a threed element)
RNDEGA	Integer, equal to 1 except in case of a threed element where it is the number of meshes where DEGASA constant has to be changed
RNDIIS	Integer, equal to 1 except in case of a threed element where it is the number of meshes where DISSOL constant has to be changed
RNCOND	Integer, equal to 1 except in case of a threed element where it is the number of meshes where CONDEN constant has to be changed
RNEVAP	Integer, equal to 1 except in case of a threed element where it is the number of meshes where EVAPOR constant has to be changed
RTABC	Array of character*8 variables: - First is the name of the element ; - It is followed by the names of the radio chemical component , - Then the list of the fuelchar names ('XXXXXXXX' in circuit or 1D element), - And then by 4 times 'XXXXXXXX' in case of a circuit or 'DEGASA ','DISSOL ', 'CONDEN ','EVAPOR ' in case of an element.
RTABI	Array of integer variables: - First are repeated IPASS, RNFUEL, RNDEGA, RNDIIS, RNCOND, RNEVAP - Then, in case of a threed element one finds the list of RNDEGA meshes numbers where - DEGASA constant has to be changed and then the list of RNDIIS meshes numbers, then RNCOND meshes numbers and finally RNEVAP meshes numbers.
RTABR	Array of real (double precision) variables: - First values for CONCENL and CONCENG, - Then values for XCOTE or XCOTEP, XRUPT and DTRUPT (0. in case of a circuit, list of RNFUEL values in case of a threed element ) - Then, in case of a threed element, the list of RNDEGA values for DEGASA constant in the meshes where it has to be changed, - Then, the same way a list of RNDIIS values, then RNCOND values and then RNEVAP real values.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 317/851

89

## INISIM DIRECTIVE

This directive is used to set the running mode of **CATHARE** to “Simulator use”, in *command block*, and should not be used otherwise.

### Associated Keywords

OPTION, VERBOSE, RESETIME, RESTORE, SAVE, MANAGE, FASTSIZE, MANAGE, OPTION, TABLE

### Syntax

**INISIM**           (isimu) ;

**isimu**           : integer value  
 0 means standard use of **CATHARE** (by default)  
 1 means use under simulator applications of EDF – IRSN.  
 2 means use under simulator applications of EDF – IRSN. Sets a “debug” level.

**N.B** : the FORTRAN subroutine called in PILOT is INISIM: CALL INISIM (isimu, \*9999).

isimu	Integer (value 0, 1 ou2)
*9999	Error code treatment

 <b>ce<sub>a</sub></b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 318/851</a>

90

## INTEGER DIRECTIVE

This directive of the *command block* allows the declaration of the **INTEGER**-type variables that will be used in the command block.

It must be used at the top of the *command block*, BEFORE ANY executable statement such as RESTORE, OPTION...

It may be used one or several times, anywhere among other declarations made by DOUBLE and CHAR8.

All integer variables of the *command block* will be SAVED in V25\_3.RESTART. These variables are automatically restored to their last value when using RESTORE directive in a second calculation.

### Associated Keywords

**CHAR8, DOUBLE**

### Syntax

```
INTEGER      NPAS          IAU          NVAL
...            ;
```

**NPAS** : liste of the INTEGER variables to restore  
**IAU**  
**NVAL**

**Warning :** Contrary to the older **CATHARE2** version (before the V2.5 series) local variables are automatically restored in restart calculations. The use of TABLE directive is then obsolescent and should be suppressed.

### Example

```
END      DATA ;
INTEGER   NOAS      IAU          NVAL      ;
...
RESTORE  ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 319/851

91

## INTEGRATE DIRECTIVE

The **INTEGRATE** directive is used , in *data block*, to link the local characteristics of a fuel assembly (FUEL object) to its global characteristics (FUELCHAR object).

**NB :** The aim of the INTEGRATE directive has changed since V1.3. Now, it does not aim at assigning a number to a given wall (or fuel wall) in a given element (an axial for example) but only at linking FUEL and FUELCHAR objects.

That is why this directive is no more used for walls and also why the keyword NUMBER is no more necessary.

### Associated Keywords

AND, FUEL, FUEL3D, FUELCHAR, GOFUEL, POWER

### Syntax

```
INTEGRATE fuel1
    NUMBER      p1           charac1      ;
```

<b>fuel1</b>	: fuel assembly object
<b>NUMBER p1</b>	: keyword followed by an integer > 0. Not used but necessary to keep the compatibility with CATHAREV1.3
<b>charac1</b>	: fuelchar object, defining the overall fuel characteristics.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 320/851

92

## INTERP OPERATOR

The **INTERP** operator allows the user interpolating linearly or logarithmically a real value. It is used in the *executive block*.

### Associated Keywords

OPENFILE, READHEAD, READVAR, REWIND, WRITHEAD, WRITVAR

### Syntax

<b>YVAL =</b>	<b>INTERP</b>						
<b>LIN</b>		or	<b>LOG</b>				
xval		x1	x2		y1		y2
							;

<b>LIN</b>	: keyword indicating that the read value will be linearly interpolated
<b>or LOG</b>	: keyword indicating that the read value will be logarithmically interpolated
xval	: abscissa
x1 x2	: abscissa interval
y1 y2	: ordinal interval

### Example

<b>YVAL=</b>	<b>INTERP</b>	<b>LIN</b>					
10.		1.	20.		30.		50. ;

**N.B** : the FORTRAN function called in PILOT is INTERPOL : YVAL = INTERPOL (MODINT , RVAL, IVSTAT)

<b>MODINT</b>	CHARACTER*3 : 'LIN' or 'LOG' or 'NO'
<b>RVAL</b>	Array of DOUBLE PRECISION (xval, x1, x2, y1, y2)
<b>IVSTAT</b>	Returned error code

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 321/851

93

## JUNCTION GROUP OPERATOR

The **JUNCTION GROUP** operator creates a junction of type **GROUP** in the *data block*. This operator must be coupled at least with the use of the **AXIAL GROUP**, **BCONDIT GROUP** and **ZONE** operators. It defines a group of identical junctions on which AXIAL GROUP or BCONDIT GROUP elements will be connected.

### Associated Keywords

**JUNCTION GROUP**, **AXIAL GROUP**, **WALL GROUP**, **FUELCHAR GROUP**, **BCONDIT GROUP**, **ZONE**, **CIRCUIT**, **PERMITIT**, **REALC**

### Syntax

<b>junc =</b>	<b>JUNCTION</b>	<b>GROUP</b>	<b>nbj</b>	<b>(SUFFIX</b>	<b>ip)</b>
<b>or</b>	<b>(WEIGHT</b>	<b>(CONST</b>	<b>iw)</b>	<b>;</b>	
	<b>(WEIGHT</b>	<b>REALLIST</b>	<b>iw1</b>	<b>...</b>	<b>iwn)</b>
					<b>;</b>

<b>junc</b>	: Name of the <b>JUNCTION GROUP</b> object. It must not exceed 5 characters.
<b>GROUP nbj</b>	: Keyword GROUP followed by a positive integer which defines the number of identical junctions that will be duplicated. It can not exceed 999.
<b>SUFFIX ip</b>	: Optional keyword followed by a positive integer which defines the number of the first duplicated junction. By default, ip = 1
<b>WEIGHT CONST iw</b>	: Optional keywords followed by a positive integer which defines the weight of the junctions to be duplicated. The weight of the duplicated junctions is identical for all the junctions of the group. By default, the weight of each junction of the group is equal to one.
<b>WEIGHT REALLIST iw1 ...iwn</b>	: Optional keywords followed by a positive integers list which defines the weight of each junction of the group.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 322/851

<b>Example</b>
----------------

**1)**  
bota=           **JUNCTION**   **GROUP**        3                   ;

The junctions created in the V25\_3.INIT file will be named bot001 to bot003. The weight of each junction will be equal to 1.

**2)**  
bota=           **JUNCTION**   **GROUP**        157  
                **SUFFIX**       **1 WEIGHT**   **CONST**        264                   ;

The junctions created in the V25\_3.INIT file will be named bot001 to bot157. The weight of each junction will be equal to 264.

**3)**  
topa=           **GROUP**       **GROUP**        3  
                **SUFFIX**       3                   **WEIGHT**  
                **REALIST**    2                1               2                   ;

The junctions created in the V25\_3.INIT file will be named topa003, topa004 and topa005. The weight will be equal to 2 for topa003, 1 for topa004 and 2 for topa005.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 323/851

94

## LAW OPERATOR

The **LAW** operator creates a law by defining the dependence of a variable y as a function of another variable x.

**Warning :** **LAW** is a *data block* operator only. In the command block, laws are directly written in the directives.

In the same input deck, you cannot define more than 100 **LAW** operators. In a **LAW** operator, you cannot define more than 100 points.

### Associated Keywords

REALIST

### Syntax

```
law1 =      LAW      variable1      variable2
           x1          y1
           x2          y2
           xi          yi
...
           xn          yn      ;
;
```

<b>law1</b>	: name of the law
<b>variable 1</b>	: name of the 1st variable (16 characters maximum between ' ').
<b>variable2</b>	: name of the 2nd variable depending on the 1st variable (16 characters maximum between ' ').
<b>xi yi</b>	: value of each of the 2 variables.

### Example

Variation law of power as a function of time

```
law1      = LAW      'TIME'      'POWER'
          0.          0.
          100.        1.
          200.        0.8
          300.        0.5
          500.        0.1
;
```

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 324/851

95

## LEVEL DIRECTIVE

The **LEVEL** directive is used after PERMIT in the command block to impose the water level in an axial or in a volume element during the steady state.

**Warning :** In case of an axial element, the mesh corresponding to the specified level (zlev) must be strictly vertical.

### Associated Keywords

**ECHPOWER, GOPERM, IMPOSFLOW, NOFLOW, PERMIT, REALC, REALVO, REALAX**

### Syntax

```
LEVEL elem zlev  

       (CONSERVH (X1) (X2) (X3) (X4));
```

**elem** : name of the axial or volume element

**zlev** : real number >0. defining the level to be imposed (m).

For a **0-D** element **zlev** is the elevation starting from the bottom.

For an **1-D** element **zlev** is the position of a vector node starting from the origin of the meshing (cuvilinear abscissa). If no vector node corresponds to zlev the nearest is chosen. The void fraction is set to  $10^{-5}$  for all scalar nodes whose elevation is below the elevation of the specified vector node.

**CONSERVH** : OPTIONAL keyword used only in VOLUME with non-condensable, to conserve the initial enthalpy(\*) of the liquid phase of the lower sub-volume, and automatic calculation of the noncondensable mass fraction in the upper sub-volume.  
 This keyword is followed by one or several keywords giving the non-condensable gas given in the list of the NONCOND directive, for which the mass fraction should be calculated.

(\*)The initial enthalpy is given by the value imposed at the 1<sup>st</sup> input junction of the lower sub-volume.

**NB:** the input junction should be the 1<sup>st</sup> junction defined in the VOLUME directive.

**X1** : OPTIONAL keyword used if the first noncondensable declared with NONCOND is in this VOLUME, its mass fraction will be calculated by **CATHARE**.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 325/851

- X2** : OPTIONAL keyword used if the second noncondensable declared with NONCOND is in this VOLUME, its mass fraction will be calculated by **CATHARE**.
- X3** : OPTIONAL keyword used if the third noncondensable declared with NONCOND is in this VOLUME, its mass fraction will be calculated by **CATHARE**.
- X4** : OPTIONAL keyword used if the forth noncondensable declared with NONCOND is in this VOLUME, its mass fraction will be calculated by **CATHARE**.

<b>Example</b>
----------------

For a volume element :

```
LEVEL      pressu      7.32      ;
```

For an axial element :

```
LEVEL      riser      1.6      ;
```

Refer to PERMIT operator for general examples of circuits initializations.

**NB:** The corresponding FORTRAN subroutine called in PILOT is LEVEL. The argument are the following ones: CALL LEVEL ( CELEM, ZLEVEL, \*9999)

CELEM	: name of the element (character*8);
ZLEVEL	: level to be imposed (double precision);

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 326/851

96

## LINK DIRECTIVE

The **LINK** directive was used, in the *data block*, to link a TEE-BRANCH to an AXIAL element. But this directive is now obsolete and, it must be replaced by the **CONNECT** directive (Cf CONNECT directive).

### Associated Keywords

CONNECT, TEE

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 327/851

97

## LIST DIRECTIVE

The **LIST** directive is used, in the *command block*, after RESTORE directive, to list one or all the objects and their own characteristics as defined in the *data block*.

**NB1** : The results will be printed on the output file.

**NB2** : The objects listed include :

1. CIRCUIT,ZONE<sup>1</sup>
2. AXIAL, VOLUME, BCONDIT, THREED, RUPTURE
3. WALL, WALL3D, FUELCHAR, REFLCHAR, REFLCH3D, EXCHANGER, SGCARACT
4. RADCHEMI, NONCOND, CORE
5. TEE, CCFL
6. ACCU, BREAK, CANDLE, PUMPCHAR, SENSOR, SINK, SOURCE, SGTR, TURBINE, ECHECK, ECVALVE, CONTROL VALVE, FLOW LIMITER, CHECK VALVE

### Associated Keywords

RESULT, PERIOD, IMPRIME, MESSAGE, PRIN3D, SAVE, TITLE

### Syntax

```
LIST      [ elem      (GROUP) ]
          [ AXE3D    axe_sect ] ;
```

**elem** : OPTIONAL name of the object to be listed. If no name is given the directive is applied to the entire REACTOR element.

If the object (axial or bcondit) is of **GROUP** type, it must be followed by the keyword **GROUP**. In that case, only the characteristics of the first element of the group are given.

**AXE3D** : OPTIONAL keyword followed by a character string indicating the THREED section  
**axe\_sect** description :

<sup>1</sup>a ZONE3D object is zone in a threed element defined in **BILAN3D** directive

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 328/851

**X or** description along Y\*Z or R\*Z section (default option)

**TETA :**

**Y or R** : description along X\*Z or TETA\*Z section

**Z** : description along X\*Y or TETA\*R section.

**NB** : The corresponding FORTRAN subroutine called in PILOT is LISTGEO : CALL LISTGEO (OBJNAM, IAXE, \*9999)

**OBJNAM** Name of the element to be listed (the name of the reactor is allowed and is equivalent to ‘REAC’).

**IAXE** Integer. Used for LIST directive for a THREED element

1 for X or TETA value of AXE3D, 2 for Y or R and 3 for Z section description.

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 329/851

98

## LOCATE3D OPERATOR

The **LOCATE3D** operator is used to get the **number** of the scalar point of a 3D-meshing corresponding to the velocity node plane number along x, y and z axis. This operator is available both in the data block and the exe block.  
**Warning :** A scalar point defined in the **data block** is unknown in the **command block**. So it has to be defined or redefined in the command block.

### Associated Keywords

### LOCATE3D

### Syntax

```
ipi=          LOCATE3D    elemi           i           j           k           ;
```

<b>elemi</b>	: name of the threed element
<b>i</b>	: integer $\geq 0$ representing the velocity node plane number along x axis
<b>j</b>	: integer $\geq 0$ representing the velocity node plane number along y axis
<b>k</b>	: integer $\geq 0$ representing the velocity node plane number along z axis

### Example

In the data block :

```
P3D1 =          LOCATE3D    2           4           6           ;
```

In the command block :

```
P3EXED1 =      LOCATE3D    2           4           6           ;
```

**Warning :** The **command block** invokes in the PILOT subroutine the ISCALAM function, corresponding to LOCATE3D operator, which returns an integer.

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 330/851

99

## LOG OPERATOR

The **LOG** operator calculates the napierian logarithm of a number. The result is a real number (DOUBLE)

The **LOG** directive can be used in both *data* and *command blocks*.

### Associated Keywords

ABSOLUTE, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, MATHEMATIC

### Syntax

**z = LOG (x) ;**

### Example

**z = LOG (10.) ;**

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 331/851

# 100

## LOWPRESS DIRECTIVE

The **LOWPRESS** directive, used in *data block*, enables the user to define within a REACTOR, a list of elements of type « CONTAINMENT ». For those elements, specific low pressure tables will be used for the water properties.

The elements defining a circuit of type « CONTAINMENT » must be of BCONDIT type or VOLUME type.

### Associated Keywords

**VOLUME, BCONDIT**

### Syntax

**LOWPRESS** elem1... elemn ;

**elem1** : Element name list. The elements must be of BCONDIT or VOLUME type.

...  
**elemn**

### Examples

Assuming that CONTAIN1 and BCIN are already defined, the following syntax can be used :

**LOWPRESS** CONTAIN1 BCIN ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 332/851

# 101

## MANAGE DIRECTIVE

The **MANAGE** directive, used in the *command block*, activates the time cycle management for a reactor. Several sub-time steps may be computed, if necessary to reach the cycle time.

The parameters are *saved* in the backup file.

The user may use the **MANAGE CYCLE** directive several times to change the initial time, the cycle time step... In this case, all cycle information are reset to zero (number of cycles), and the user must first stop the previous management using the **MANAGE NOCYCLE** directive before using again the directive.

This directive has been designed for uses of **CATHARE** in realtime simulators.

### Associated Keywords

**OPTION, VERBOSE, RESETIME, RESTORE, SAVE, INISIM, FASTSIZE**

### Syntax

```
MANAGE      elem      CYCLE      tinit      dtcycle ;
           or        NOCYCLE   ;
```

<b>elem</b>	: name of a <i>reactor</i> object.
<b>CYCLE</b>	: keyword used to enable the time cycle mode. The keyword is followed by :
<b>tinit</b>	- real number $\geq 0$ . defining the beginning time for the first cycle.
<b>dtcycle</b>	- real number $> 0$ . defining the time step to be calculated in each time cycle (i.e. the first time to reach is $tinit+dtcycle$ ). It must be greater or equal to DTMAX imposed with the <b>OPTION</b> directive.
<b>NOCYCLE</b>	: keyword used to disable the time cycle mode and to return to the standard <b>CATHARE</b> time step management (default).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 333/851

**N.B :**

1. If the DTMAX imposed with the **OPTION** directive is used after the **MANAGE** directive, **dtcycle** is set up to DTMAX value .
2. If **dtcycle** is greater than DTMAX, the effective value of the time step will be DTMAX.

<b>Example</b>
----------------

```

RESETIME    CIRCTOT      0.D0          ;
TIME=        0.           ;
DTCYCLE=    0.1D0         ;
MANAGE      CIRCTOT      CYCLE       TIME       DTCYCLE      ;

```

**NB :** The corresponding FORTRAN call is : CALL MANAGE (IFLAG, COPT, CELEM,TDEBCYCL,DTCYCLE,  
\*9999)

IFLAG	INTEGER value 0 unsets specified COPT, 1 sets specified COPT
COPT	CHARACTER*8 COPT timestep management option CYCLE or NOCYCLE
CELEM	CHARACTER*8 reactor name
TDEBCYCL	DOUBLE PRECISION value of the current reactor time
DTCYCLE	DOUBLE PRECISION value of the cycle timestep

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 334/851

102

## MANIFOLD DIRECTIVE

The **MANIFOLD** directive, used in the data block, can be applied to any volume element to model the imbalance of liquid temperatures or radio-chemical products at the volume inlets and to carry it at the volume outlets. This directive triggers an incomplete mixture model inside the specified volume.

No executable block (BLOCK EXEC) language directive is associated to this feature ; actuating and exchanging data with the **MANIFOLD** model must be done through a **(MPa)UTILx** by calling the dedicated interface subroutine SMANIFO with appropriate arguments.

### Associated Keywords

**VOLUME, (MPa)UTILx**

### Syntax

<b>MANIFOLD</b>	volume				
<b>AGMAX</b>	agmaxi	<b>DQMAX</b>	dqmaxi		
<b>OUTLET</b>	n				
	OJun_1	OJun_i	...	OJun_n	
<b>( DELAY</b>	( MULTIPY	fact )			
<b>INLET</b>	m				
	IJun_1	IJun_i	...	IJun_m )	;

**MANIFOLD**              Name of the volume on which the specific model will be used.  
**volume**

**AGMAX**              Maximum void fraction at outlet ports of manifold for which the incomplete mixture model can be applied.  
**agmaxi**

**DQMAX**              Maximum value of the asymmetry (Qmax-Qmin)/Qmin ratio between flowrates at outlet ports for which the incomplete mixture model can be applied.  
**dqmaxi**

**OUTLET**              Number of outlet ports driven by the incomplete mixture model.  
**n**

**OJun\_i**              Names of the outlet ports driven by the incomplete mixture model.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 335/851

Optional

<b>(DELAY</b>	Activating transport delay model instead of (default) instantaneous model.
<b>(MULTIPLY fact)</b>	Multiplier for the transport time constant (convection time) - optional if using DELAY model.
<b>INLET</b>	Number of outlet ports driven by the incomplete mixture model.
<b>m</b>	
<b>IJun_i)</b>	Names of the inlet ports driving the incomplete mixture model (mandatory if using DELAY model).

### Example

In the "BLOC DATA" section, following the definition of the UPPLLEN volume element,

```

MANIFOLD UPPLLEN
AGMAX 1.D-1
DQMAX 1.0D0
OUTLET 3 CHAUDE1 CHAUDE2 CHAUDE3
DELAY MULTIPY 1.2
INLET 1 MIDUPP ;

```

In the "BLOC EXEC" section, the actuation and data specification of the model are provided (inside an UTIL procedure) by the following "Fortran CALL" to the hat\pilot\SMANIFO.f interface subroutine.

```

C providing data to the model
character*8 flag
INTEGER nloop
PARAMETER (nloop = 3)
DOUBLE PRECISION coeff(2,nloop)
INTEGER j
C
flag = 'USERDATA'
C
C sample data for 3 loop reactor configuration
C enthalpy coefficients (line #1)
j = 1
coeff(j,1) = 1230.d0
coeff(j,2) = 1255.d0
coeff(j,3) = 1280.d0
C radchemi coefficients (line #2)
j = 2
coeff(j,1) = 1.00d0
coeff(j,2) = 1.02d0
coeff(j,3) = 1.01d0
C
call SMANIFO ('UPPLLEN '

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 336/851

```

&      , 1, 1, 2*nloop
&      , flag, nloop, coeff
&      , *9999)
C
C enabling/disabling the model calculation
C
C   flag ='ON'  or  flag ='OFF'
C
call SMANIFO ('UPPLEN '
&           , 1, 0, 0
&           , flag, ibid, rbid
&           , *9999)

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 337/851

# 103

## MATERIAL OPERATOR

The **MATERIAL** operator used, in the *data block*, creates a MATERIAL element by defining its properties.

This operator allows to define new materials which can be used in the definition of the walls like the **CATHARE** predefined materials.

### WARNINGS :

1. The user can not define more than **10 materials**,
2. The material must be created in the data block before it is used in a wall definition,
3. The properties are defined by polynomial functions in a range of wall temperature. If the wall temperature is not in the given range, **CATHARE** calculation stops.

### Associated Keywords

**WALL, WALL3D, FUELPLAQ**

### Syntax

Mater =	<b>MATERIAL</b>	<b>MINTEMP</b>	<b>Tmin</b>	<b>MAXTEMP</b>	<b>Tmax</b>
		<b>LAMBDA</b>	nx	x <sub>1</sub> ... x <sub>nx</sub>	
		<b>RO</b>	ny	y <sub>1</sub> ... y <sub>ny</sub>	
		<b>CP</b>	nz	z <sub>1</sub> ... z <sub>nz</sub>	;

**mater** : Name of the material element.  
**WARNING** : the name of the material must be different of the names of **CATHARE** predefined materials (see **WALL** operator to know these names).

**MINTEMP** : Keyword followed by a real number Tmin > 0. The properties of this material are available above temperature Tmin.  
**MAXTEMP** : Keyword followed by a real number Tmax > 0. The properties of this material are available below temperature Tmax.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 338/851

<b>LAMBDA</b>	: Keyword to indicate that the material conductivity will be given as a polynomial of the wall temperature ( $T_W$ in °C) :
	$\lambda = x_1 + x_2 \cdot T_W + x_3 \cdot T_W^2 + \dots + x_{nx} \cdot T_W^{nx-1}$
	It is followed by :
<b>nx</b>	: The number of coefficients
$x_1 \dots x_{nx}$	: The polynomial coefficients
<b>RO</b>	: Keyword to indicate that the material density will be given as a polynomial of the wall temperature ( $T_W$ in °C) :
	$\rho = y_1 + y_2 \cdot T_W + y_3 \cdot T_W^2 + \dots + y_{ny} \cdot T_W^{ny-1}$
	It is followed by :
<b>ny</b>	: The number of coefficients
$y_1 \dots y_{ny}$	: The polynomial coefficients
<b>CP</b>	: Keyword to indicate that the material calorific capacity will be given as a polynomial of the wall temperature ( $T_W$ in °C) :
	$C_p = z_1 + z_2 \cdot T_W + z_3 \cdot T_W^2 + \dots + z_{nz} \cdot T_W^{nz-1}$
	It is followed by :
<b>nz</b>	: The number of coefficients
$z_1 \dots z_{nz}$	: The polynomial coefficients

### Example

```

BETON =      MATERIAL    MINTEMP    10.D0      MAXTEMP    500.D0
              LAMBDA      2          1.7D0      2.D-3
              RO          1          2300.D0
              CP          3
              800.D0      0.2D0      4.D-6
;

```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 339/851

# 104

## MATHEMATICAL OPERATORS

### 104.1 \* OPERATOR

The **\*** operator multiplies the two operands. The result is either an **INTEGER** if both operands are integers, or a **DOUBLE** (real number) if not.

#### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

#### Syntax

K =            I                \*                J;

#### Example

```
x1 =      2.      *      DT ;
x2 =      2.      *      3. ;      (x2=6.)
x3 =      2      *      3 ;      (x3=6)
x4 =      2      *      3. ;     (x4=6.)
```

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.



## **104.2 \*\* OPERATOR**

The **\*\* operator** raises the operand to a power. The result is either an **INTEGER** if both operands are integers, or a **DOUBLE** (real number) if not.

## Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

## Syntax

K = I \*\* J;

## Example

```
x1 = DT      **      2. ;  
x2 = 2.      **      2. ;      (x2=4.)  
x3 = 2.      **      2 ;      (x3=4.)  
x4 = 2      **      2 ;      (x4=4)
```

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/ ) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.



# 104.3 + OPERATOR

The **+** operator adds two operands. The result is either an **INTEGER** if both operands are integers, or a **DOUBLE** (real number) if not.

## Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

## Syntax

$$K = I + J;$$

## Example

```
x1 = DT + 2. ; (x2=4.)
x2 = 2. + 2. ; (x3=4.)
x3 = 2. + 2; (x4=4)
x4 = 2 + 2; (x4=4)
```

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.



## **104.4 - OPERATOR**

The **- operator** calculates the difference between two operands. The result is either an **INTEGER** if both operands are integers, or a **DOUBLE** (real number) if not.

## Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

## Syntax

$$K = I - J;$$

## Example

```
x1 = DT - 2. ;  
x2 = 6. - 2. ; (x2=4.)  
x3 = 6. - 2; (x3=4.)  
x4 = 6 - 2; (x4=4)
```

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/.) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 343/851

## 104.5 / OPERATOR

The **/ operator** divides the first operand by the second. The result is an **INTEGER** if both operands are integers, or a **DOUBLE** (real number) if not.

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

K =                I                /                J;

### Example

x1 =	DT	/	2. ;
x2 =	6.	/	2. ;
x3 =	6.	/	2 ;
x4 =	6	/	2 ;

(x2=3.)  
(x3=3.)  
(x4=3)

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 344/851

## 104.6 < OPERATOR

The < operator compares two operands (**INTEGER** or **DOUBLE** (real number)). It returns TRUE if the first operand is smaller than the second one. The < operator has to be used within a test in command block only. The commands following the comparison up to the corresponding ENDIF or ELSE statement will be executed if the comparison result is TRUE .

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Example

```

1)
IF      ( I      <      J );
      K =      I ;
ENDIF;

2)
IF      ( I      <      J );
      K =      I ;
      ELSE ;
      K =      J ;
ENDIF;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 345/851

## 104.7 <EQ OPERATOR

The **<EQ operator** compares 2 operands (**INTEGER** or **DOUBLE** (real numbers)). It returns TRUE if the first operand is smaller than or equal to the second one. The **<EQ** operator has to be used within a test in command block only. The commands following the comparison up to the corresponding **ENDIF** or **ELSE** statement will be executed if the comparison is TRUE.

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Example

```

IF          ( A      >EQ      B );
             IMAX =    A ;
ELSE;
             IMAX =    B ;
ENDIF;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 346/851

## 104.8 > OPERATOR

The **>** operator compares 2 operands (**INTEGER** or **DOUBLE** (real numbers)). It returns TRUE if the first operand is greater than the second one. The **>** operator has to be used within a test in command block only. The commands following the comparison up to the corresponding ENDIF or ELSE statement will be executed if the comparison is **TRUE**.

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

```

1)
IF          ( I           <           J ) ;
            K =           I ;
ENDIF ;

2)
IF          ( I           <           J ) ;
            K =           I ;
ELSE ;
            K =           J ;
ENDIF ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 347/851

## 104.9 >EQ OPERATOR

The **>EQ** operator compares 2 operands (**INTEGER** or **DOUBLE** (real numbers)). It returns TRUE if the first operand is greater or equal to the second one. The **>EQ** operator has to be used within a test in command block only. The commands following the comparison up to the corresponding ENDIF or ELSE statement will be executed if the comparison is **TRUE**.

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Example

```

IF          ( A      >EQ      B );
IMAX =      A ;
ELSE ;
IMAX =      B ;
ENDIF ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 348/851

## 104.10 ABSOLUTE OPERATOR

The **ABSOLUTE** operator, in data block, calculates the absolute value of the operand. The operand can be either **INTEGER** or **DOUBLE** (real number). The result is of the same type as the operand.

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

X1 =           **ABSOLUTE**   (X) ;

### Example

I =	<b>ABSOLUTE</b>	(1);	<b>(I = 1)</b>
X =	<b>ABSOLUTE</b>	(-2.3) ;	<b>(X = 2.3)</b>

**NB :** In the present version parenthesis are necessary when operators (+,-,\*,/) are combined. The use of blanks between operands and operators is recommended, but not necessary for arithmetical expressions. Maximum length for all variables is 8 characters.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 349/851

# 105

## MAX OPERATOR

It can be used in the command *block only*.

The **MAX** operator determines the maximum value of several INTEGER or REAL variables. The result is either a real or an integer variable depending on the type of the main result (integer or real definition).

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

```
x =      MAX      a      b      c      ...      j ;
```

<b>x</b>	: Integer or real variable
<b>a b c ...j</b>	: list of integer or real variables

### Example

TW is a real number. ITW is an integer.

```
DOUBLE    TW      T1      T3      ;
INTEGER   IT2      ;
...
TW =      MAX      T1      IT2      T3      ;
or
DOUBLE    T1      T3      ;
INTEGER   IT2      ITW      ;
...
ITW =      MAX      T1      IT2      T3      ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 350/851

# 106

## MESH DIRECTIVE

The **MESH** directive allocates a mesh grid to elements of axial- or threed- types, in *data block*.

### 106.1 Meshing of a 1-D element

The **MESH** directive should precede :

1. The definition of the geometry (GEOM directive);
2. The definition of the singular head loss coefficients ( SINGULAR);
3. The definition of the submodules or gadgets linked with the AXIAL element.

#### Associated Keywords

XAXIS, SEGMENT, AXIAL, HYDR, GEOM, SINGULAR

#### Syntax

**MESH** elem1 mesh1 ;

**elem1** : axial type element.  
**mesh1** : mesh object.

The mesh must be a continuous line. The curvilinear x-coordinates must be given in increasing order. The mesh is then considered to be described from the first junction to the second.

**Remarks :** The following recommendations should be carefully observed for a pipe :

- define the mesh before the geometry,
- define a fine mesh in regions with strong variations of cross-section,
- respect a maximum ratio of 1.2 between two adjacent elementary meshes (this ratio can be increased in regions where the physical parameters vary slowly as a function of the coordinate),

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 351/851

- owing to the discretization considered for the closure equations, at an axial-axial junction, the lengths of the elementary meshes on either side of the junction must be comparable,
- similarly, at an axial-volume junction, the length of the last elementary mesh of the pipe must be equal to about 2% of the total height of the volume,
- a 90° bend in a vertical plane must include at least 3 elementary meshes,
- a pipe must contain at least 5 vector nodes (and thus 4 elementary meshes) and can contain at most 150 vector nodes (149 elementary meshes),
- When modeling a break with a meshed pipe, it is strongly recommended to end up the pipe with a cylindrical part containing at least 3 elementary meshes, the length of the order of a millimeter for each mesh ; it is advisable to test the mesh convergence in this region,
- in cases of natural circulation or operation at low flow velocity (slow pump rate), it is advisable to have a fairly fine mesh for vertical pipes near the junctions in order to allocate properly the gravity term.

### Example

```
t1 =          P1           SEGMENT    12
              P2           cos        0.          ;
MESH      channel       t1           ;
```

## 106.2 Meshing of a 3-D element element

The **MESH** operator is **compulsory** in the definition of a **threed** module and must appear in *the data block*. It enables the definition of the hydraulic meshing of the element and creates any global zone of scalar, X vector, Y vector or Z vector type node. It should be the first operator applied to the threed element.

**NB :** For all information related to 3D numbering refer to the user manual appendix “Numbering in 3D elements”

### Associated Keywords

THREED, CONNECT, HYDR, GEOM, PHYSCALE, SINGULAR, LOCATE3D

### Syntax

```
MESH      elem
COORDINA  RECTANGLE
or       CYLINDER   ANGLE     angl1
or       ANNULAR    ANGLE     angl2      RADIUS     rint
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 352/851

<b>MESHING</b>	<b>X</b>	(or	<b>TETA )</b>	nx		
<b>MESHING</b>	<b>Y</b>	(or	<b>R )</b>	ny		
<b>MESHING</b>	<b>Z</b>			nz		
<b>GRAVITY</b>	<b>X</b>	(or	<b>TETA )</b>	gx		
<b>GRAVITY</b>	<b>Y</b>	(or	<b>R )</b>	gy		
<b>GRAVITY</b>	<b>Z</b>			gz		
<b>MESHSIZE</b>	<b>X</b>	(or	<b>TETA)</b>	<b>LISTVOL</b>		
			dx1	...	dxn	
			or	<b>LIST_DX</b>		
			dx1	...	dxnx	
			or	<b>DEFAULT</b>	dx	
			or	<b>ANGLE</b>	xfract	
<b>MESHSIZE</b>	<b>Y</b>	(or	<b>R)</b>	<b>LISTVOL</b>		
			dy1	...	dyn	
			or	<b>LIST_DY</b>		
			dy1	...	dyny	
			or	<b>DEFAULT</b>	dy	
<b>MESHSIZE</b>	<b>Z</b>		<b>LISTVOL</b>			
			dz1	...	dzn	
			or	<b>LIST_DZ</b>		
			dz1	...	dznz	
			or	<b>DEFAULT</b>	dz	
<b>ZONEDEF</b>	s_zone					
	ibeg	iend	jbeg	jend	kbeg	kend
<b>ZONEDEFX</b>	vx_zone					
	ibeg	iend	jbeg	jend	kbeg	kend
<b>ZONEDEFY</b>	vy_zone					
	ibeg	iend	jbeg	jend	kbeg	kend
<b>ZONEDEFZ</b>	vz_zone					
	ibeg	iend	jbeg	jend	kbeg	kend
<b>ZONEDEFG</b>	vx_zone	vy_zone	vz_zone			
	ibeg	iend	jbeg	jend	kbeg	kend

<b>MESH</b>	: operator to define the meshing of the element starting with the description of the coordinates (COORDINA), then the number of mesh cells in every direction (MESHING), the gravity values (GRAVITY) and the size of the mesh cells for each direction (MESHSIZE).
<b>Elem</b>	: 3d element name
<b>COORDINA</b>	: keyword to introduce the type of coordinates used to describe the 3-D element. It is followed by :
<b>RECTANGLE</b>	: keyword indicating the use of rectangular coordinates
<b>or CYLINDER</b>	: keyword indicating the use of cylindrical coordinates. It is followed by
<b>ANGLE ang1</b>	: keyword followed by a real number equal to the value of the angle (rad) of the first TETA mesh with the reference axis (for a closed cylinder ang1=0).
<b>or ANNULAR</b>	: keyword indicating the use of cylindrical coordinates to describe an annular geometry (internal radius ≠ 0). It is followed by :

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 353/851</a>

<b>ANGLE ang12</b>	: keyword followed by a real number equal to the value of the angle (rad) of the first TETA mesh with the reference axis (for a closed ring ang12=0).
<b>RADIUS rint</b>	: keyword followed by a real number equal to the value of the first internal radius (m).
<b>MESHING</b>	: keyword to introduce the number of mesh cells in each direction of the coordinate system. It has to be repeated for every direction. It is followed by : Rectangular coordinates :
<b>X nx</b>	: keyword indicating the X direction, followed by an integer equal to the number of meshes in X-direction.
<b>Y ny</b>	: keyword indicating the Y direction, followed by an integer equal to the number of meshes in Y-direction.
<b>Z nz</b>	: keyword indicating the Z direction, followed by an integer equal to the number of meshes in Z-direction. Cylindrical coordinates :
<b>TETA nx</b>	: keyword, indicating the TETA direction, followed by an integer equal to the number of meshes in TETA direction. <b>Warning</b> : For a full cylinder TETA must not be equal to 2. (nx =1,3,4...)
<b>R ny</b>	: keyword indicating the R direction, followed by an integer equal to the number of meshes in R-direction.
<b>Z nz</b>	: keyword indicating the Z direction, followed by an integer equal to the number of meshes in Z-direction.
<b>GRAVITY</b>	: keyword to introduce the gravity values on each direction. It has to be repeated for every direction. Rectangular coordinates :
<b>X gx</b>	: keyword indicating the X-direction followed by a real number equal to the gravity value in the X direction ( $m/s^2$ )
<b>Y gy</b>	: keyword indicating the Y-direction followed by a real number equal to the gravity value in the Y direction ( $m/s^2$ )
<b>Z gz</b>	: keyword indicating the Z-direction followed by a real number equal to the gravity value in the Z direction ( $m/s^2$ ) Cylindrical coordinates :
<b>TETA gteta</b>	: keyword indicating the TETA-direction followed by a real number equal to the gravity value in the TETA direction ( $m/s^2$ )
<b>R gr</b>	: keyword indicating the R-direction followed by a real number equal to the gravity value in the R direction ( $m/s^2$ )
<b>Z gz</b>	: keyword indicating the Z-direction followed by a real number equal to the gravity value in the Z direction ( $m/s^2$ ) <b>Warning</b> : The THREED module can only model cylinders with vertical Z-axis, therefore gteta and gr must necessarily be set to zero.
<b>MESHSIZE</b>	: keyword to introduce the mesh cell dimension on each direction. It has to be repeated for every direction. It is followed by :  rectangular coordinates:
<b>X</b>	: keyword indicating the X direction. It is followed by :
<b>LISTVOL dx1 ... dxn</b>	: keyword followed by a list of n real numbers equal to the different mesh cell lengths on X direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (m). This definition refers to scalar numbering of the 3D elements.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 354/851

**or LIST\_DX dx1 ...** : keyword followed by a list of nx real numbers equal to the different mesh cell lengths on the X direction (see MESHING). In that case, all the edges in the same (Y , Z) plane have the same length (m).  
**dxnx**  
This definition refers to scalar numbering of the 3D elements.

**or DEFAULT dx** : keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (m).

**Y** : keyword indicating the Y direction. It is followed by :

**LISTVOL dy1 ...** : keyword followed by a list of n real numbers equal to the different mesh cell lengths on Y direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (m).  
**dyn**  
This definition refers to scalar numbering of the 3D elements.

**or LIST\_DY dy1 ...** : keyword followed by a list of ny real numbers equal to the different mesh cell lengths on the Y direction (see MESHING). In that case, all the edges in the same (X , Z) plane have the same length (m).  
**dyny**  
This definition refers to Y vector numbering of 3D elements.

**DEFAULT dy** : keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (m).

**Z** : keyword indicating the Z direction. It is followed by :

**LISTVOL dz1 ...** : keyword followed by a list of nz real numbers equal to the different mesh cell lengths on Z direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (m).  
**dzn**  
This definition refers to scalar numbering of the 3D elements.

**or LIST\_DZ dz1 ...** : keyword followed by a list of nz real numbers equal to the different mesh cell lengths on the Z direction (see MESHING). In that case, all the edges in the same (X , Y) plane have the same length (m).  
**dznz**  
This definition refers to scalar numbering of the 3D elements.

**or DEFAULT dz** : keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (m).

**TETA** cylindrical coordinates :  
**LISTVOL dx1 ...** : keyword indicating the TETA direction. It is followed by:  
**dxn** : keyword followed by a list of n real numbers equal to the different mesh cell lengths on TETA direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (rad).  
This definition refers to scalar numbering of the 3D elements.

**or LIST\_DX dx1 ...** : keyword followed by a list of nx real numbers equal to the different mesh cell lengths on the TETA direction (see MESHING). In that case, all the edges in the same (R , Z) plane have the same length (rad).  
**dxnx**  
This definition refers to scalar numbering of the 3D elements.

**or DEFAULT dteta** : keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (rad).

**or ANGLE xfract** : keyword followed by a real number  $0. < xfract \leq 2$ . It is used to define a regular meshing of nx meshes on TETA direction. Each mesh cell size along TETA is an equal fraction of  $2\pi$ ; xfract is then equal to  $\frac{2}{nx}$ . In that case, all the edges in the same (R , Z) plane have the same length.

**R** : keyword indicating the R direction. It is followed by :

**LISTVOL dy1 ...** : keyword followed by a list of n real numbers equal to the different mesh cell lengths on R direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (m).  
**dyn**  
This definition refers to scalar numbering of the 3D elements.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 355/851

- or LIST\_DY dy1 ...** : keyword followed by a list of ny real numbers equal to the different mesh cell lengths on the R direction (see MESHING ). In that case, all the edges in the same (TETA , Z) plane have the same length (m).  
**dyny**  
This definition refers to scalar numbering of the 3D elements.
- or DEFAULT dr** : keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (m).
- Z** : keyword indicating the Z direction. It is followed by :
- LISTVOL dz1 ...** : keyword followed by a list of n real numbers equal to the different mesh cell lengths on Z direction. In that case, the edge length has to be specified for all the mesh cells of the 3-D element (m).  
**dzn**  
This definition refers to scalar numbering of the 3D elements.
- or LIST\_DZ dz1 ...** : keyword followed by a list of nz real numbers equal to the different mesh cell lengths on the Z direction (see MESHING ). In that case, all the edges in the same (TETA , R) plane have the same length (m).  
**dznz**  
This definition refers to scalar numbering of the 3D elements.
- or DEFAULT dz** : Keyword followed by a real number > 0. and equal to the uniform size of all the meshes in the specified direction (m).
- ZONEDEF** : OPTIONAL keyword introducing the definition of a global scalar zone for the threed element. This keyword may be repeated as many times as needed. It is followed by :  
**szone**  
**ibeg iend**  
**jbeg jend**  
**kbeg kend**  
: Name of the scalar node zone to be defined.  
: 6 integers for velocity node plane number boundary of the defined scalar zone. To exist, the scalar zone shall verify the following conditions : ibeg<iend, jbeg<jend and kbeg<kend.
- ZONEDEFX** : OPTIONAL keyword introducing the definition of a global VX node zone for the threed element. This keyword may be repeated as many times as needed. It is followed by :  
**vx\_zone**  
**ibeg iend**  
**jbeg jend**  
**kbeg kend**  
: Name of the VX node zone to be defined.  
: 6 integers for velocity node plane number boundary of the defined VX node zone. To exist, the VX node zone shall verify the following conditions : ibeg≤iend, jbeg<jend and kbeg<kend.
- ZONEDEFY** : OPTIONAL keyword introducing the definition of a global VY node zone for the threed element. This keyword may be repeated as many times as needed. It is followed by :  
**vy\_zone**  
**ibeg iend**  
**jbeg jend**  
**kbeg kend**  
: Name of the VY node zone to be defined.  
: 6 integers for velocity node plane number boundary of the defined VY node zone. To exist, the VY node zone shall verify the following conditions : ibeg<iend, jbeg≤jend and kbeg<kend.
- ZONEDEFZ** : OPTIONAL keyword introducing the definition of a global VZ node zone for the threed element. This keyword may be repeated as many times as needed. It is followed by :  
**vz\_zone**  
**ibeg iend**  
**jbeg jend**  
**kbeg kend**  
: Name of the VZ node zone to be defined.  
: 6 integers for velocity node plane number boundary of the defined VZ node zone. To exist, the VZ node zone shall verify the following conditions : ibeg<iend, jbeg<jend and kbeg≤kend.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 356/851

**ZONEDEFG** : OPTIONAL keyword introducing the definition of four global zones for the *elem* threed element : scalar zone, X vector zone, Y vector zone and Z vector. This option may be repeated as many times as needed. It is followed by :  
**s\_zone** : Names of the four grid zones to be defined.  
**vx\_zone**  
**vy\_zone vz\_zone**  
**ibeg iend** : 6 integers for velocity node plane number boundary of the four defined zones. To exist, the zones shall verify the following conditions : ibeg<iend, jbeg<jend and kbeg<kend.  
**jbeg jend**  
**kbeg kend**

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 357/851</a>

# 107

## MESSAGE DIRECTIVE

The **MESSAGE** directive allows to print a message composed of character strings or local variables and is used in the *command block*.

### Associated Keywords

**RESULT, PERIOD, LIST, IMPRIME, PRIN3D, SAVE, TITLE**

### Syntax

```
MESSAGE      obj1          obj2          ...          ;
```

**obj1** : character string, integer or real type.

### Example

```
DOUBLE      TIME       DT        ACHK      ;  
TRANSIENT   CIRPRIM   TIME      DT        ;  
  
MESSAGE     'AT TIME'  TIME      'THE CORE  VOID IS'  ACHK      ;  
  
END         EXEC      ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 358/851

# 108

## MIN OPERATOR

It can be used in the *command block* only.

The **MIN** operator determines the minimum value of several INTEGER or REAL variables : the result is either a real or an integer variable depending on the type of the main result (integer or real definition).

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

```
x =      MIN      a      b      c      ...      j ;
```

**x** : Integer or real variable  
**a b c** : list of integer or real variables

### Example

```
DOUBLE      TW      T1      T3      ;  

INTEGER    IT2      ;  

...  

TW =      MIN      T1      IT2      T3      ;  

        (TW is a real  

        number)  

or  

DOUBLE      T1      T3      ;  

INTEGER    IT2      ITW      ;  

...  

ITW =      MIN      T1      IT2      T3      ;  

        (ITW is an in-  

        teger)
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 359/851

# 109

## MODEL DIRECTIVE

The **MODEL** directive allocates a boundary condition model to a **BCONDIT** type object, in the *data block*.

**BCONDIT** type object can be of two types :

1. **Internal type** : The time dependence of the variables is defined with corresponding lists in the boundary condition description.
2. **External type** : The variables in the boundary condition description are given initially without time dependence. Then their time dependence is made by using the **WRITE** directive in the command block to impose some **CATHARE** Computation Variables (CCV), or it is given by another hydraulic module linked to the boundary (refer to **EXHYLINK** operator).

**BEWARE that the choice of **BCONDIT** type is definitive.** One cannot change, the **BCMOD** directive, an external into an internal model and vice versa during calculation.

List of the models available in the present version :

1. BLIND,
2. BC3x Internal type,
  - (a) BC3x available boundary condition : BC3A, BC3B, BC3C, BC3D, BC3E, BC3F, BC3G, BC3H,
3. BC3 External type,
4. BC4x Internal or External type,
  - (a) BC4x Internal type available boundary condition : BC4A, BC4B, BC4C,
  - (b) BC4x External type available boundary condition : BC4A, BC4C,
5. BC5x Internal or External available boundary condition : BC5A, BC5B,
6. BC5YY Internal type,
7. BC5XX Internal or External type,
8. BC5ZZ Internal or External type,
9. SAFETYVA Internal type,
10. BC5HO External type.

NB :

1. Each boundary condition has its own syntax depending of the model type. However, the keyword **STEADY** is available for most of them. In that case, **CATHARE** will impose the steady state values for the transient computation.

The keyword **STEADY** is not available for **BLIND**, **SAFETYVA** and **BC5HO** models.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 360/851

2. The syntax of each model allows the user to impose either steady state values, or saturation values corresponding to the partial pressure PV, or saturation values corresponding to the total pressure P by using specific numbers.  
 Depending of the fluid chosen by the user, the specific numbers are the following :

Available for MODEL directive	O2, H2 and USERS fluids	Other fluids
Steady state values	-999.D9	-999.
Saturation values corresponding to the total pressure P	-1.D9	-1.
Saturation values corresponding to the partial pressure PV	-100.D9	-100.

#### Associated Keywords

**BCCONDIT, BCMOD, MONOPHAS(E)**

#### Syntax

**MODEL** elem1 modeltype ... ;

**elem1** : element of Boundary Condition (BCCONDIT) type.  
**modeltype** : model name.

**NB:**

- For all the models, the signs of the velocities and flowrates are :  $\geq 0$  when the fluid flows from the boundary condition to the adjacent element.
- Never impose 0. on velocities or flowrates but  $10^{-7}$
- The minimum value to simulate the null value is  $10^{-15}$  (m/s, kg/s)

## 109.1 BLIND model

This condition imposes VL and VV steady state values when it used in the *data block*.

It can represent a closed end of an element.

For this model, STEADY keyword is not available.

## Syntax

Syntax used in the *data bloc*. For the syntax used in *command block*, see **BCMOD** directive.

**MODEL** elem1 **BLIND** ;

**elem1** : element of Boundary Condition type.

## 109.2 BC3x Internal type (inlet type conditions)

In these models, the inlet variables are defined with respect to time. The maximum number of points is 100.

---

## Syntax

<b>MODEL</b>	elem1		
	BC3x	( <b>STEADY</b> )	;
	or		
VAR1	list1		
VAR2	list2		
ALFA	list3		
(X1	list4)		
(X2	list5)		
(X3	list6)		
(X4	list7)		
VAR8	list10		
VAR9	list11		
(LIQFRXi	list8)		
(GASFRXi	list9)		
ABSTIME	list12		:

**elem1** : Boundary Condition element with **DSTREAM** junction type.  
**BC3x** : name of the model, **BC3A**, **BC3B**, **BC3C**, **BC3D**, **BC3E**, **BC3F**, **BC3G**, **BC3H**  
**STEADY** : Optional keyword to impose steady state values

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 362/851

**Name of the variables VAR1 ... VAR9, according to the model :**

	BC3A	BC3B	BC3C	BC3D	BC3E	BC3F	BC3G	BC3H
VAR1	HL	TL	HL	HL	TL	TL	TL	UNDERSAT
VAR2	HG	TG	HG	HG	TG	TG	TG	OVERHEAT
VAR8	VL	VL	JL	QL	QL	GAMMA	GAMMA	QL
VAR9	VV	VV	JV	QG	QG	P	QT	QG

<b>P</b>	: pressure (Pa).
<b>HL</b>	: liquid enthalpy (J/kg)
<b>HG</b>	: gas enthalpy (J/kg)
<b>TL</b>	: liquid temperature (°C)
<b>TG</b>	: gas temperature (°C)
<b>UNDERSAT</b>	: difference between saturation temperature and liquid temperature (in °C)
<b>OVERHEAT</b>	: difference between overheated steam temperature and saturation temperature (in °C)
<b>ALFA</b>	: void fraction
<b>X1</b>	: mass fraction of the 1 <sup>st</sup> non-condensable gas ( <i>optional</i> )
<b>X2</b>	: mass fraction of the 2 <sup>nd</sup> non-condensable gas ( <i>optional</i> )
<b>X3</b>	: mass fraction of the 3 <sup>rd</sup> non-condensable gas ( <i>optional</i> )
<b>X4</b>	: mass fraction of the 4 <sup>th</sup> non-condensable gas ( <i>optional</i> )
<b>LIQFRXi</b>	: concentration of radio-chemical element #i in the liquid phase (kg/kg or GBq/kg), 1 ≤ i ≤ 12 ( <i>optional</i> )
<b>GASFRXi</b>	: concentration of radio-chemical element #i in the gas phase (kg/kg or GBq/kg), 1 ≤ i ≤ 12 ( <i>optional</i> )
<b>VL</b>	: liquid velocity (m/s)
<b>VV</b>	: gas velocity (m/s)
<b>JL</b>	: liquid superficial velocity (1-ALFA) * VL (m/s)
<b>JV</b>	: gas superficial velocity ALFA * VV (m/s)
<b>QL</b>	: liquid flow rate (kg/s)
<b>QG</b>	: gas flow rate (kg/s)
<b>QT</b>	: total flow rate (kg/s)
<b>ABSTIME</b>	: time (s)
<b>GAMMA</b>	: slip ratio VV/VL

**NB :**

1. The lists of real numbers of one MODEL must have the same number of values.
2. The syntax allows the user to impose either steady state or saturation values by using specific numbers. Depending on the fluid chosen by the user, the specific numbers are the following.

To impose steady state values of <b>HL, HG, ALFA, Xi, VL, VV</b>	set	O2, H2 or USERS fluids <b>-999.D9</b>	Other fluids <b>-999.</b>
To impose saturation values of <b>HL, TL, HG, TG</b>	set	O2, H2 or USERS fluids <b>-1.D9</b>	Other fluids <b>-1.</b>

3. The time law must start at time zero.

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 363/851

<b>Example</b>
----------------

A boundary condition BC3A is first defined, then changed into a new model BC3H.

```

BEGIN      DATA      ;
hllist =    REALLIST -1.          -1.          -1.          -1.          ;
MODEL      entrei   BC3
HL         hllist
HG          (REALLIST -1.          -1.          -1.          -1. )
ALFA        (REALLIST -999.       -999.       -999.       -999. )
VL          (REALLIST 1.D-3      2.D-3      3.D-3      3.D-3 )
VV          (REALLIST 1.D-3      2.D-3      3.D-3      3.D-3 )
ABSTIME     (REALLIST 0.00       1.          2.          3. ) ;

END        DATA      ;
RESTORE    ;
DOUBLE     tt        tt1         tt2         tt3         ;
           qg0       q10        qg1        qg2        qg3        ;
tt          = time ;
tt1         = tt + 1. ;
tt2         = tt + 2. ;
tt3         = tt + 3. ;
qg0         = VALUE GASFLOW canal p1 ;
q10         = VALUE LIQFLOW canal p1 ;
qg1         = qg0 + 0.1 ;
qg2         = qg1 + 0.1 ;
qg3         = qg2 + 0.1 ;

```

```

BCMOD      entrei   BC3H
UNDERSAT   (REALLIST 0.          0.          1.          2.          2. )
OVERHEAT    (REALLIST 0.          0.          1.          2.          4. )
ALFA        (REALLIST 0.001      0.002      0.003      0.004      0.004 )
QL          (REALLIST -999.      q10        q10        q10        q10 )
QG          (REALLIST -999.      qg0        qg1        qg2        qg3 )
ABSTIME     (REALLIST 0.          tt         tt1        tt2        tt3 ) ;

BCMOD      entrei   BC3G      STEADY      ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 364/851

## 109.3 BC3 External type (inlet type conditions)

In these models, the inlet variables are defined by using **CATHARE** Computation Variables (CCV).

### Syntax

<b>MODEL</b>	elem1	
	<b>BC3</b>	<b>EXTERNAL</b> <b>(STEADY)</b> ;
or		
	<b>HLIQEXT</b>	(or or or <b>HGASEXT</b> (or or or <b>ALFAEXT</b> <b>(X1EXT</b> <b>(X2EXT</b> <b>(X3EXT</b> <b>(X4EXT</b> <b>(LIQFRXi</b> <b>(GASFRXi</b> <b>VLEXT</b> (or or or <b>QTEXT</b> (or or or <b>TLIQEXT</b> <b>UNDERSAT</b> <b>UNDERSPV</b> )    Val1 <b>TGASEXT</b> <b>OVERHEAT</b> <b>OVERHEPV</b> )    Val2 Val3 Val4) Val5) Val6) Val7) Val8) Val9) <b>JLEXT</b> <b>QLEXT</b> <b>GAMEXT</b> )    Val10 <b>JGEKT</b> <b>VGEXT</b> <b>QGEXT</b> )    Val11         ;

<b>elem1</b>	: Boundary Condition element with <b>DSTREAM</b> junction type.
<b>STEADY</b>	: Optional keyword to impose steady state values
<b>HLIQEXT</b>	: keyword followed by the external liquid enthalpy (J/kg)
<b>HGASEXT</b>	: keyword followed by the external gas enthalpy (J/kg)
<b>TLIQEXT</b>	: keyword followed by the external liquid temperature (°C)
<b>TGASEXT</b>	: keyword followed by the external gas temperature (°C)
<b>UNDERSAT</b>	: difference between saturation temperature and liquid temperature (in °C)
<b>OVERHEAT</b>	: difference between overheated steam temperature and saturation temperature (in °C)
<b>ALFAEXT</b>	: keyword followed by the external void fraction
<b>X1EXT</b>	: keyword followed by the external mass concentration of the 1 <sup>st</sup> non-condensable gas ( <i>optional</i> )
<b>X2EXT</b>	: keyword followed by the external mass concentration of the 2 <sup>nd</sup> non-condensable gas ( <i>optional</i> )
<b>X3EXT</b>	: keyword followed by the external mass concentration of the 3 <sup>rd</sup> non-condensable gas ( <i>optional</i> )
<b>X4EXT</b>	: keyword followed by the external mass concentration of the 4 <sup>th</sup> non-condensable gas ( <i>optional</i> )
<b>LIQFRXi</b>	: keyword followed by the external concentration of radio-chemical element #i in the liquid phase (kg/kg or GBq/kg). 1 ≤ i ≤ 12 ( <i>optional</i> )

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 365/851

<b>GASFRXi</b>	: keyword followed by the external concentration of radio-chemical element #i in the gas phase (kg/kg or GBq/kg). $1 \leq i \leq 12$ ( <i>optional</i> )
<b>VLEXT</b>	: keyword followed by the external liquid velocity (m/s)
<b>VGEXT</b>	: keyword followed by the external steam velocity (m/s)
<b>JLEXT</b>	: keyword followed by the external liquid superficial velocity $(1-\text{ALFA}) * \text{VL}$ (m/s)
<b>JGEXT</b>	: keyword followed by the external gas superficial velocity $\text{ALFA} * \text{VV}$ (m/s)
<b>QLEXT</b>	: keyword followed by the external liquid flow rate (kg/s)
<b>QGEXT</b>	: keyword followed by the external gas flow rate (kg/s)
<b>QTTEXT</b>	: keyword followed by the external total flow rate (kg/s)
<b>GAMEXT</b>	: keyword followed by the external slip ratio $\text{VV}/\text{VL}$

#### **CAUTIONS :**

- Solved equations are not depending on the liquid and gas velocity sign at the boundary condition.
- The time step may decrease when the solved equations change at a boundary condition.

#### **Example**

MODEL	ENTREE2	BC3	EXTERNAL
	HLIQEXT	1296.0D3	
	HGASEXT	2700.0D3	
	VLEXT	1.0D-5	
	VGEXT	1.0D-5	;
MODEL	ENTREE2	BC3	EXTERNAL STEADY ;

## 109.4 BC4x, BC5x Internal type (outlet type conditions)

For these models, the time-dependent variation in pressure must be defined. The maximum number of points is 100. The law must be given as a function of absolute time and must start at time zero.

The points of the law are defined inside the model definition without using a law type object. REALLIST must be used as a keyword followed by a list of real numbers, but it does not create an object of realist type.

**N.B. :** The pressure law must have a sufficient number of points in order to avoid drastically sharp conditions that the code will not be able to take into account. The BC4A, BC4B models give the possibility of a variation in pressure with choking conditions.

### 109.4.1 BC4A Model

This model is generally used to simulate the opening of a break at the end of a nozzle. The pressure is given as a function of time. The sonic blocking condition is calculated by means of characteristics method.

In case of entering liquid phase, the imposed void fraction is the void fraction on the last scalar node calculated at the previous time step.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 366/851

Syntax
--------

```

MODEL elem1
BC4A      (STEADY)    ;
or
P          REALIST   p1      ...      pn
ABSTIME   REALIST   t1      ...      tn
;
```

#### 109.4.2 BC4B Model

BC4B is the same as BC4A model, except that the pressure law is given as a function of the relative time (initial time is the break opening time tt1).

In case of entering liquid phase, the imposed void fraction is the void fraction of the last scalar node calculated at the previous time step.

Syntax
--------

```

MODEL elem1
BC4B      (STEADY)    ;
or
P          REALIST   p1      ...      pn
RELTIME   REALIST   t1      ...      tn
TBRECH    tt1       ;
;
```

#### 109.4.3 BC4C Model

BC4C syntax is the same as BC4A. However a different condition is imposed on the void fraction in case of entering liquid phase (ALFA=0.999999 imposed on the last scalar node).

#### 109.4.4 BC5A Model

This model is generally used to simulate a pressure condition at the outlet of an element without sonic blocking. In case of entering liquid phase, the imposed void fraction on the last scalar node is equal to 0.999999.

Syntax
--------

```

MODEL elem1
BC5A      (STEADY)    ;
or
P          REALIST   p1      ...      pn
ABSTIME   REALIST   t1      ...      tn
;
```

#### 109.4.5 BC5B Model

BC5B syntax is the same as BC5A. However a different condition is imposed on the void fraction in case of entering liquid phase (the imposed void fraction is the void fraction of the last scalar node calculated at the previous time step).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 367/851

<b>Elem1</b>	: Boundary Condition (BCONDIT) element.
<b>BC4A, BC4B,</b>	: name of the model.
<b>BC4C, BC5A,</b>	
<b>BC5B</b>	
<b>STEADY</b>	: optional keyword to impose steady state values
<b>P</b>	: keyword P followed by the keyword REALIST and a list of values (with or without parenthesis) defining pressure values versus time as specified below
<b>ABSTIME</b> <b>or RELTIME</b>	: keyword followed by the keyword REALIST and a list of values (with or without parenthesis) defining times for which pressure is given. <b>RELTIME is used only for the BC4B model</b> to indicate that the law is given as a function of time relatively to the break opening time.
<b>TBRECH tt1</b>	: keyword followed by a real $\geq 0$ . defining the absolute break opening time, <b>for the BC4B model only</b> .

### Example

```

MODEL      outlet      BC4A
          P           REALIST   132.6D5    132.6D5    1.0D5     1.0D5
          ABSTIME    REALIST   0.          3.0D-3    5.0D-3   100.0D0
;

```

```

MODEL      outlet BC4A      STEADY ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 368/851

## 109.5 BC4x, BC5x External type (outlet type conditions)

For these models, the variables are not time-dependant. They are imposed by means of **CATHARE** Computation Variables (VCC).

### 109.5.1 BC4A Model

The sonic blocking condition is calculated by means of characteristics method. In case of entering liquid phase, the imposed void fraction is the void fraction of the last scalar node calculated at the previous time step.

#### Syntax

```
MODEL      elem1
  BC4A      EXTERNAL  (STEADY)    ;
  or
  PEXT      Val1       ;
```

### 109.5.2 BC4C Model

For BC4C model the syntax is the same as BC4A. However a different condition is imposed on the void fraction in case of entering liquid phase (ALFA=0.999999 is imposed on the last scalar node).

### 109.5.3 BC5A Model

This model is generally used to simulate a pressure condition at the outlet of an element without sonic blocking. In case of entering liquid phase, the imposed void fraction on the last scalar node is equal to 0.999999.

#### Syntax

```
MODEL      elem1
  BC5A      EXTERNAL  (STEADY)    ;
  or
  PEXT      Val1       ;
```

### 109.5.4 BC5B Model

For BC5B model the syntax is the same as BC5A. However a different condition is imposed on the void fraction in case of entering liquid phase (the imposed void fraction is the void fraction of the last scalar node calculated at the previous time step).

elem1	: Boundary Condition (BCCONDIT) element.
BC4A, BC4C, BC5A, BC5B	: name of the model.
STEADY	: optional keyword to impose steady state value
PEXT	: keyword followed by the external pressure (Pa).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 369/851

### Example

```

MODEL      outlet      BC4A      EXTERNAL
          PEXT       30.D5      ;
MODEL      outlet      BC4A      EXTERNAL      STEADY      ;

```

## 109.6 BC5XX, BC5ZZ, BC5YY (Internal type model )

In these models the variables are defined versus time.

The maximum number of points is 100. Values should be given with REALLIST objects previously defined.  
The time laws should be given as a function of absolute time and must start at time zero.

### 109.6.1 BC5XX

This model allows to simulate entering or exiting conditions. It allows also counter current flow for the following case: gas entering and liquid exiting the system during the transient. All variables depend on the same time list.

### Syntax

<b>MODEL</b>	<b>elem1</b>		
<b>BC5XX</b>		<b>(STEADY)</b>	;
or			
<b>HL</b>	(or	<b>TL</b>	
	or	<b>UNDERSPV</b>	
	or	<b>UNDERSAT</b> )	list1
<b>HG</b>	(or	<b>TG</b>	
	or	<b>OVERHEPV</b>	
	or	<b>OVERHEAT</b> )	list2
<b>ALFA</b>			list3
<b>(X1</b>			list4)
<b>(X2</b>			list5)
<b>(X3</b>			list6)
<b>(X4</b>			list7)
<b>(LIQFRXi</b>			list8)
<b>(GASFRXi</b>			list9)
<b>GAMMA</b>			list10
<b>QT</b>	(or	<b>P</b> )	list11
<b>ABSTIME</b>			list12

### 109.6.2 BC5ZZ

This model generalises the BC5XX boundary conditions since it allows to simulate either entering or outgoing flow conditions, as well as all types of counter current flows. All the variables depend on the same time list. The difference from BC5XX model consists in permitting also a counter current flow when the liquid enters and the gas exits the system

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 370/851

during the transient (different equations in this case).

<b>Syntax</b>
---------------

<b>MODEL</b>	elem1			
	<b>BC5ZZ</b>	<b>(STEADY)</b>	;	
	or			
	<b>HL</b>	(or	<b>TL</b>	
		or	<b>UNDERSPV</b>	
		or	<b>UNDERSAT</b> )	list1
	<b>HG</b>	(or	<b>TG</b>	
		or	<b>OVERHEPV</b>	
		or	<b>OVERHEAT</b> )	list2
	<b>ALFA</b>			list3
	<b>(X1</b>			list4)
	<b>(X2</b>			list5)
	<b>(X3</b>			list6)
	<b>(X4</b>			list7)
	<b>(LIQFRXi</b>			list8)
	<b>(GASFRXi</b>			list9)
	<b>GAMMA</b>	(or	<b>QL</b> )	
		or	<b>VL</b>	list10
	<b>QT</b>	(or	<b>P</b> )	
		or	<b>JG</b>	
		or	<b>VG</b>	
		or	<b>QG</b>	list11
	<b>ABSTIME</b>			list12

### 109.6.3 BC5YY

This model allows to simulate entering or outgoing conditions as BC5XX (the same equations are written), but each variable has its own time list.

<b>Syntax</b>
---------------

<b>MODEL</b>	elem1			
	<b>BC5YY</b>	<b>(STEADY)</b>	;	
	or			
	<b>HL</b>	(or	<b>TL</b>	
		or	<b>UNDERSPV</b>	
		or	<b>UNDERSAT</b> )	list1
	<b>ABSTIME</b>			list1
	<b>HG</b>	(or	<b>TG</b>	
		or	<b>OVERHEPV</b>	
		or	<b>OVERHEAT</b> )	list2
	<b>ABSTIME</b>			list2
	<b>ALFA</b>			list3
	<b>ABSTIME</b>			list3

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 371/851

<b>(X1</b> <b>ABSTIME</b>	list4) list4
<b>(X2</b> <b>ABSTIME</b>	list5) list5
<b>(X3</b> <b>ABSTIME</b>	list6) list6
<b>(X4</b> <b>ABSTIME</b>	list7) list7
<b>(LIQFRXi</b> <b>ABSTIME</b>	list8) list8
<b>(GASFRXi</b> <b>ABSTIME</b>	list9) list9
<b>(GAMMA</b> <b>ABSTIME</b>	list10) list10
<b>QT</b> <b>ABSTIME</b>	(or <b>P</b> ) list11 list11

### **CAUTIONS:**

1. The equations to be solved depend on the liquid and gas velocity sign at the boundary condition. The time step may decrease when these equations change during the time step at a boundary condition.
2. A physical solution does not exist in all cases when the mass flowrate is imposed at an outlet boundary condition. It would be better to impose pressure.
3. The pressure law (if used) must have a sufficient number of points in order to avoid drastic change of pressure that the code will not be able to follow.

<b>elem1</b>	: name of the boundary condition (BCONDIT) element
<b>BC5XX or BC5YY</b>	: name of the model
<b>or BC5ZZ</b>	
<b>STEADY</b>	: optional keyword to impose steady state values
<b>HL</b>	: liquid enthalpy (J/kg)
<b>HG</b>	: gas enthalpy (J/kg)
<b>TL</b>	: liquid temperature (°C)
<b>TG</b>	: gas temperature (°C)
<b>UNDERSAT</b>	: difference between saturation temperature and liquid temperature (°C): $T_{sat}(P) - T_L$
<b>UNDERSPV</b>	: difference between saturation temperature and liquid temperature (°C): $T_{sat}(P_V) - T_L$
<b>OVERHEAT</b>	: difference between overheated steam temperature and saturation temperature (°C): $T_G - T_{sat}(P)$
<b>OVERHEPV</b>	: difference between overheated steam temperature and saturation temperature (°C): $T_G - T_{sat}(P_V)$
<b>ALFA</b>	: void fraction <b>NB</b> : The void fraction must be between 1.D-5 and 1.-1.D-6.
<b>X1</b>	: mass concentration of the 1 <sup>st</sup> non-condensable ( <i>optional</i> )

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 372/851</a>

<b>X2</b>	: mass concentration of the 2 <sup>nd</sup> non-condensable ( <i>optional</i> )
<b>X3</b>	: mass concentration of the 3 <sup>rd</sup> non-condensable ( <i>optional</i> )
<b>X4</b>	: mass concentration of the 4 <sup>th</sup> non-condensable ( <i>optional</i> )
	<b>NB :</b> The mass concentration of each non-condensable gas must be between 0 and 1 (and their sum should range from 0 to 1).
<b>LIQFRXi</b>	: concentration of radio-chemical element #i in the liquid phase (kg/kg or GBq/kg). $1 \leq i \leq 12$ ( <i>optional</i> )
<b>GASFRRXi</b>	: concentration of radio-chemical element #i in the gas phase (kg/kg or GBq/kg). $1 \leq i \leq 12$ ( <i>optional</i> )
<b>GAMMA</b>	: slip ratio ( $\frac{V_V}{V_L}$ ) <b>NB :</b> The slip ratio must be greater than 1.d-10.
<b>VL</b>	: liquid velocity (m/s)
<b>JL</b>	: liquid superficial velocity (1-ALFA) * VL (m/s)
<b>QL</b>	: liquid mass flow rate (kg/s)
<b>QT</b>	: total mass flow rate (kg/s)
<b>P</b>	: total pressure (Pa)
<b>VG</b>	: gas velocity (m/s)
<b>JG</b>	: gas superficial velocity ALFA * VG (m/s)
<b>QG</b>	: gas mass flow rate (kg/s)
<b>ABSTIME</b>	: absolute time (s)

These keywords are followed by a REALLIST object (see operator REALLIST).

For the **BC5XX** and **BC5ZZ** models all the thermal-hydraulic variables follow the same number of values time list. Thus all the lists must contain the same number of values.

For the **BC5YY** model, each thermal-hydraulic variable is described following its own time list. Thus the lists of the both the thermal-hydraulic variable and the associated time variable must contain the same number of values.

**NB :**

1. The time law must start at time zero.
2. The syntax allows the user to impose either the steady-state or saturation values by using specific numbers. Depending on the fluid chosen by the user, the specific numbers are the following :

To impose <b>steady state values</b> of HL, HG, ALFA, Xi, VL, VV	set	O2, H2 or USERS fluids <b>- 999.D9</b>	Other fluids <b>-999.</b>
To impose <b>saturation values</b> of HL, HG, TL, TG, <b>corresponding to partial pressure PV</b>	set	<b>- 100.D9</b>	<b>-100.</b>
To impose <b>saturation values</b> of HL, HG, TL, TG, <b>corresponding to total pressure P</b>	set	<b>- 1.D9</b>	<b>-1.</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 373/851

### Examples

**Boundary condition BC5XX :**

```

ALRELTO = 1.d-5      ;
list1 = REALIST    2.      3.      3.      ;
list2 = REALIST    1.      1.      1.      ;
list3 = REALIST    ALRELTO  0.1     0.2     ;
list4 = REALIST    -999.    0.6     0.1     ;
list5 = REALIST    -999.    1.      1.5     ;
list6 = REALIST    -999    -999.   -999.   ;
list7 = REALIST    0.       1.      2.      ;

```

```

MODEL      entrei      BC5XX
UNDERSPV   list1
OVERHEAT   list2
ALFA       list3
X1         list4
GAMMA      list5
QT         list6
ABSTIME    list7 ;

```

**Boundary condition BC5YY :**

```

ALRELTO = 1.D-5;
list1a = REALIST    -999.    -999.   -100.    ;
list1t = REALIST    0.        1.       2.       ;
list2a = REALIST    -999.    -100.   -100.    ;
list3a = REALIST    ALRELTO  0.1     0.2     ;
list3t = REALIST    0.        0.5     2.      ;
list4a = REALIST    -999.    0.6     0.65    0.8;
list4t = REALIST    0.        0.01   0.1     2. ;
list5a = REALIST    -999.    0.6     0.1     ;
list6a = REALIST    -999.    10.d5  1.d5    ;
list6t = REALIST    0.        1.d-3  2.      ;

```

```

MODEL      entrei      BC5YY
TL         list1a
ABSTIME   list1t
HG         list2a
ABSTIME   list1t
ALFA      list3a
ABSTIME   list3t
X1         list4a
ABSTIME   list4t
GAMMA     list5a

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 374/851

ABSTIME list1t  
P list6a  
ABSTIME list6t ;

MODEL entrei BC5YY STEADY ;

## 109.7 BC5XX or BC5ZZ External type model

This model is an external inlet or outlet type condition. The variables are not time-dependant in description of these boundary conditions. The equations are the same as those written by BC5XX (or respectively BC5ZZ) internal models.

<b>MODEL</b>	<b>elem1</b>			
	<b>BC5XX</b>	<b>or</b>	<b>BC5ZZ</b>	
	<b>EXTERNAL</b>			
<b>(STEADY)</b>	<b>;</b>			
	<b>;</b>			
	<b>or</b>			
	<b>HLIQEXT</b>	<b>(or</b>	<b>TLIQEXT</b>	
		<b>or</b>		
		<b>or</b>	<b>UNDERSPV</b>	
	<b>HGASEXT</b>	<b>(or</b>	<b>UNDERSAT</b> )	<b>val1</b>
		<b>or</b>	<b>TGASEXT</b>	
		<b>or</b>	<b>OVERHEPV</b>	
		<b>or</b>	<b>OVERHEAT</b> )	<b>val2</b>
	<b>ALFAEXT</b>			<b>val3</b>
	<b>(X1EXT</b>			<b>val4)</b>
	<b>(X2EXT</b>			<b>val5)</b>
	<b>(X3EXT</b>			<b>val6)</b>
	<b>(X4EXT</b>			<b>val7)</b>
	<b>(LIQFRXi</b>			<b>val8)</b>
	<b>(GASFRXi</b>			<b>val9)</b>
	<b>VLEXT</b>	<b>(or</b>	<b>JLEXT</b>	
		<b>or</b>	<b>QLEXT</b>	
		<b>or</b>	<b>GAMEXT</b> )	<b>val10</b>
	<b>PEXT</b>	<b>(or</b>	<b>QTEXT</b>	
		<b>or</b>	<b>JGEXT</b>	
		<b>or</b>	<b>VGEXT</b>	
		<b>or</b>	<b>QGEXT</b> )	<b>val11</b>
				<b>;</b>

**elem1** : element of Boundary Condition (BCONDIT) type  
**STEADY** : optional keyword to impose steady state values  
**HLIQEXT** : keyword followed by the external liquid enthalpy (J/kg)  
**TLIQEXT** : keyword followed by the external liquid temperature (°C)  
**UNDERSAT** : difference between saturation temperature and liquid temperature :  $T_{sat}(P) - T_L$  (°C)  
**UNDERSPV** : difference between saturation temperature and liquid temperature :  $T_{sat}(P_V) - T_L$  (°C)

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 375/851

<b>HGASEXT</b>	: keyword followed by the external gas enthalpy (J/kg)
<b>TGASEXT</b>	: keyword followed by the external gas temperature (°C)
<b>OVERHEAT</b>	: difference between overheated steam temperature and saturation temperature: $T_G - T_{sat}(P)$ (°C)
<b>OVERSPV</b>	: difference between overheated steam temperature and saturation temperature: $T_G - T_{sat}(P_V)$ (°C)
<b>ALPHAEEXT</b>	: keyword followed by the external void fraction
<b>X1EXT</b>	: keyword followed by the external mass concentration of the 1 <sup>st</sup> non-condensable gas ( <i>optional</i> )
<b>X2EXT</b>	: keyword followed by the external mass concentration of the 2 <sup>nd</sup> non-condensable gas ( <i>optional</i> )
<b>X3EXT</b>	: keyword followed by the external mass concentration of the 3 <sup>rd</sup> non-condensable gas ( <i>optional</i> )
<b>X4EXT</b>	: keyword followed by the external mass concentration of the 4 <sup>th</sup> non-condensable gas ( <i>optional</i> )
<b>VLEEXT</b>	: keyword followed by the external liquid velocity (m/s)
<b>JLEXT</b>	: keyword followed by the external superficial liquid velocity (m/s)
<b>QLEXT</b>	: keyword followed by the external liquid mass flow rate (kg/s)
<b>GAMEXT</b>	: keyword followed by the external slip ratio VV/VL
<b>PEXT</b>	: keyword followed by the external pressure (Pa)
<b>VGEXT</b>	: keyword followed by the external gas velocity (m/s)
<b>JGEXT</b>	: keyword followed by the external superficial gas velocity (m/s)
<b>QEEXT</b>	: keyword followed by the external gas mass flow rate (kg/s)
<b>QTTEXT</b>	: keyword followed by the external total mass flow rate (kg/s)
<b>LIQFRXi</b>	: keyword followed by the concentration of radio-chemical element #i in the liquid phase (kg/kg or GBq/kg) $1 \leq i \leq 12$ ( <i>optional</i> )
<b>GASFRXi</b>	: keyword followed by the concentration of radio-chemical element #i in the gas phase (kg/kg or GBq/kg) $1 \leq i \leq 12$ ( <i>optional</i> )

#### CAUTION :

1. The equations to be solved depend on the liquid and gas velocity sign at the boundary condition. The time step may decrease when equations change during the time step at a boundary condition.
2. Physical solution does not exist for all cases when the mass flowrate is imposed at an outlet boundary condition. It would be better to impose the pressure

#### Example

#### In the data block

MODEL	bcout	BC5XX	EXTERNAL
	TLIQEXT	20.D0	
	TGASEXT	20.D0	
	ALFAEXT	0.99999D0	
	X1EXT	0.9D0	
	X2EXT	0.D0	
	X3EXT	0.D0	
	GAMEXT	1.D0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 376/851

```

PEXT      1.D5
LIQFRX1   1.D-2
LIQFRX2   1.D-2
GASFRX1   1.D-2
GASFRX2   1.D-2 ;
```

```
MODEL      bcout      BC5XX      EXTERNAL      STEADY ;
```

## 109.8 SAFETYVA Internal type model

This model is used to simulate a safety valve. The outside is not represented (counter pressure, fluid characteristics). For this model, STEADY keyword is not available.

### Syntax

<b>MODEL</b>	<b>elem1</b>	<b>SAFETYVA</b>			
	<b>WATER</b>	<b>CAPA</b>	z1	<b>HREF</b>	z3
		<b>PREF</b>	z2		
	<b>STEAM</b>	<b>CAPA</b>	z4		
		<b>PREF</b>	z5	<b>HREF</b>	z6
	<b>PCALIB</b>	z7	<b>DP</b>	z8	;

<b>elem1</b>	: name of a BCONDIT element.
<b>SAFETYVA</b>	: keyword, name of the model.
<b>WATER</b>	: keyword to introduce the water capacity of the safety valve description.
<b>CAPA z1</b>	: keyword followed by a positive real number : water capacity of the safety valve (kg/m <sup>2</sup> /s).
<b>PREF z2</b>	: keyword followed by a positive real number : reference pressure corresponding to the water capacity of the safety valve (Pa).
<b>HREF z3</b>	: keyword followed by a positive real number : reference enthalpy corresponding to the water capacity of the safety valve (J/kg).
<b>STEAM</b>	: keyword to introduce the steam capacity of the safety valve description.
<b>CAPA z4</b>	: keyword followed by a positive real number : steam capacity of the safety valve (kg/m <sup>2</sup> /s).
<b>PREF z5</b>	: keyword followed by a positive real number : reference pressure corresponding to the steam capacity of the safety valve (Pa).
<b>HREF z6</b>	: keyword followed by a positive real number : reference enthalpy corresponding to the steam capacity of the safety valve (J/kg).
<b>PCALIB z7</b>	: keyword followed by a positive real number : calibration pressure of the safety valve (Pa).
<b>DP z8</b>	: keyword followed by a real number : opening deltap of the safety valve (Pa).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 377/851

<b>Example</b>
----------------

```

safetyv1=    BCNDIT    soupress    USTREAM    ;
MODEL        safetyv1    SAFETYVA
WATER        CAPA       300.          PREF        152.D5
              HREF       1400.4D3
STEAM        CAPA       150.          PREF        177.D5
              HREF       2544.4D3
PCALIB       163.D5    DP           1.D5        ;

```

## 109.9 BC5HO External type model

This boundary condition allows the modelization of a manhole :

1. The boundary condition must be first defined as BLIND boundary condition in the data block.
2. Then, the BC5HO model is activated in the command block under BCMOD directive.

For this model, the variables are not time-dependant, they can be changed by means of CCV. The keyword EXTERNAL is not necessary.

For this model, STEADY keyword is not available.

<b>Syntax</b>
---------------

<b>BCMOD</b>	<b>elem1</b>	<b>BC5HO</b>
	<b>TLIQEXT</b>	val1
	<b>TGASEXT</b>	val2
	<b>ALFAEXT</b>	val3
	<b>(X1EXT</b>	val4)
	<b>(X2EXT</b>	val5)
	<b>(X3EXT</b>	val6)
	<b>(X4EXT</b>	val7)
	<b>(LIQFRXi</b>	val8)
	<b>(GASFRXi</b>	val9)
	<b>GAMEXT</b>	val10
	<b>PEXT</b>	val11
	<b>(DTOPEN</b>	dt1) ;

<b>elem1</b>	: element of Boundary Condition (BCNDIT) type
<b>TLIQEXT</b>	: keyword followed by the external liquid temperature (°C)
<b>TGASEXT</b>	: keyword followed by the external gas temperature (°C)
<b>ALFAEXT</b>	: keyword followed by the external void fraction

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 378/851

<b>X1EXT</b>	: keyword followed by the external mass concentration of the 1 <sup>st</sup> non-condensable gas <i>(optional)</i>
<b>X2EXT</b>	: keyword followed by the external mass concentration of the 2 <sup>nd</sup> non-condensable gas <i>(optional)</i>
<b>X3EXT</b>	: keyword followed by the external mass concentration of the 3 <sup>rd</sup> non-condensable gas <i>(optional)</i>
<b>X4EXT</b>	: keyword followed by the external mass concentration of the 4 <sup>th</sup> non-condensable gas <i>(optional)</i>
	<b>NB :</b> The mass concentration of each non-condensable gas must be between 0 and 1 (and their sum should range from 0 to 1).
<b>GAMEXT</b>	: keyword followed by the external slip ratio VV/VL
<b>PEXT</b>	: keyword followed by the external pressure (Pa)
<b>LIQFRXi</b>	: keyword followed by the concentration of radio-chemical element #i in the liquid phase (GBq/kg or kg/kg). 1 ≤ i ≤ 12 <i>(optional)</i>
<b>GASFRXi</b>	: keyword followed by the concentration of radio-chemical element #i in the gas phase (GBq/kg or kg/kg). 1 ≤ i ≤ 12 <i>(optional)</i>
<b>DTOPEN</b>	OPTIONAL keyword followed by a positive real number giving the time (s) by which the manhole is fully open. Default value is 0.

<b>Example</b>
----------------

**In the data block**

```
MODEL      manhole      BLIND      ;
```

**In the command block**

BCMOD	manhole	BC5HO
	TLIQEXT	20.D0
	TGASEXT	20.D0
	ALFAEXT	0.99999D0
	X1EXT	0.9D0
	X2EXT	0.D0
	X3EXT	0.D0
	GAMEXT	1.D0
	PEXT	1.D5
	LIQFRX1	1.D-2
	LIQFRX2	1.D-2
	GASFRX1	1.D-2
	GASFRX2	1.D-2 ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 379/851

# 110

## MODGRAV DIRECTIVE

The **MODGRAV** directive must be used *in the command block* only in order to change the time dependant law of gravity.

### Associated Keywords

REACTOR, CIRCUIT

### Syntax

```
MODGRAV  GRAVITY    (REALIST   grav1      ...      gravn )
          ABSTIME   (REALIST   t1        ...      tn      );

```

**GRAVITY** : keyword GRAVITY followed by the keyword REALIST and a list of values (with or without parenthesis) defining gravity variation for time values described below.  
**ABSTIME** : keyword followed by the keyword REALIST and a list of values (with or without parenthesis) defining time instant for which gravity is given

### Example

```
MODGRAV  GRAVITY    9.81D0      4.D0      1.5D0
          REALIST
          ABSTIME   0.D0        1.D0      1.2D5      ;
          REALIST
```

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 380/851</a>

111

## MODPCST DIRECTIVE

The **MODPCST** directive is used in *command block* to modify the turbine power definition from the efficiency mode (EFFI in data deck) to the power mode. The power has first to be defined by means of a CCV (POWER) then the directive MODPCST has to be used to make the change effective.

### Associated Keywords

**MODPNCST, TURBINE, BWR**

### Syntax

**MODPCST**      **turbi**                ;

**turbi**                : name of the turbine element.

**N.B** : the FORTRAN subroutine called in PILOT is MODPCST : CALL MODPCST (OBJNAM, \*9999)

**OBJNAM**                Character\*8 variable, name of the turbine operator

### Example

*In data block*

```

TURB1 =      TURBINE      STEAMLIN
          POINT        P10
          SNOZZLE     4.1D-2
          DELTAP      12.D-2
          EFFI        0.9
          GAMMA      1.4;
END          DATA;
  
```

*In command block*

```

WRITE      1.D3        POWER      TURB1;
MODPCST   TURB1;
  
```

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 381/851</a>

# 112

## MODPNCST DIRECTIVE

The **MODPNCST** directive is used in *command block* to modify the turbine power definition from the power mode (POWER in data deck) to the efficiency mode. The efficiency has first to be defined by means of a CCV (EFFI) then the directive MODPNCST has to be used to make the change effective.

### Associated Keywords

**MODPCST, TURBINE, BWR**

### Syntax

**MODPNCST**    turbi                ;

**turbi**                : name of the turbine element.

**N.B** : the FORTRAN subroutine called in PILOT is MODPNCST : CALL MODPNCST(OBJNAM, \*9999)

OBJNAM                Character\*8 variable, name of the turbine operator

### Example

*In data block*

```

TURB2 =      TURBINE      STEAMLIN
          POINT        P10
          SNOZZLE     4.1D-2
          DELTAP       12.D-2
          POWER        100.D3
          GAMMA       1.4;
END DATA;
  
```

*In command block*

```

WRITE      0.8        EFFI        TURB2;
MODPCST   TURB2;
  
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 382/851

# 113

## MODXNEUT DIRECTIVE

The **MODXNEUT** directive, in the *command block*, allows the user to modify the XNEUT parameter of a fuelchar object, when neutronic power becomes smaller than a certain rate of the core total power.

It becomes effective when it is called.

**Remark:** MODXNEUT directive has been specially designed for LB-LOCA computations.

### Associated Keywords

FUELCHAR, CORE

### Syntax

```
MODXNEUT fuelchar1
           xneutmod
           ( rate )      ;
```

<b>fuelchar1</b>	: name of the fuelchar element for which the XNEUT factor is to be modified.
<b>xneutmod</b>	: value of XNEUT when the neutronic power becomes lower than the following rate of the core total power.
<b>( rate )</b>	: OPTIONAL keyword (default value = 0.1) threshold under which the modification of XNEUT parameter becomes effective

### Example

```
DOUBLE      XNEUMOD     XRATE      ;
...
XNEUMOD=   0.98D0      ;
XRATE =    0.15D0      ;
...
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 383/851

MODXNEUT CARCHO1 XNEUMOD XRATE ;  
 MODXNEUT CARCHO2 XNEUMOD ;  
 MODXNEUT CARCHO3 0.9810 0.15 ;  
 MODXNEUT CARCHO4 0.9810 ;  
 ...

**NB1** : the FORTRAN subroutine called in PILOT is MODXNEUT: CALL MODXNEUT ( OBJNAM, XNEUMOD, PUINOM, \*9999)

OBJNAM	CHARACTER*8 name of the fuelchar whose XNEUT factor will be modified.
XNEUMOD	DOUBLE PRECISION new value of XNEUT when applicable
PUINOM	DOUBLE PRECISION threshold under which the modification is effective

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 384/851</a>

114

## MODXRES DIRECTIVE

The **MODXRES** directive, in the *command block*, allows the user to modify the XRES parameter of a FUELCHAR or FUELPLAQ object, when neutronic power becomes smaller than a given rate of the core total power. XRES is the fraction (between 0 and 1) of the power dissipated in a fuel rod.

It becomes effective when it is called.

**Remark:** MODXRES directive has been specially designed for LB-LOCA computations.

### Associated Keywords

FUELCHAR, FUELPLAQ, XRESLIST, XRESLISX

### Syntax

```
MODXRES    fuelchar1
              xresmod
              ( rate )      ;
```

<b>fuelchar1</b>	: name of the fuelchar or fuelplaq element for which the XRES factor will be modified.
<b>xresmod</b>	: value of XRES when the neutronic power becomes lower than the following rate of the core total power.
<b>( rate )</b>	: OPTIONAL keyword (default value = 0.1) threshold under which the modification of XRES term becomes effective

### Example

```
DOUBLE      XRESMOD     XRATE      ;
...
XRESMOD =  0.98D0      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 385/851

XRATE =      0.15D0      ;  
...  
MODXRES    CARCHO1    XRESMOD    XRATE      ;

MODXRES    CARCHO2    XRESMOD    ;

MODXRES    CARCHO3    0.9810      0.15      ;

MODXRES    CARCHO4    0.9810      ;

...

**NB :** the FORTRAN subroutine called in PILOT is MODXRES :CALL MODXRES ( OBJNAM, XRESMOD, PUINOM, \*9999)

OBJNAM	CHARACTER*8 name of the fuelchar or fuelplaq whose XRES factor will be modified.
XRESMOD	DOUBLE PRECISION new value of XRES when applicable
PUINOM	DOUBLE PRECISION threshold under which the modification is effective

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 386/851

115

## MONOPHAS(E) DIRECTIVE

The **MONOPHAS(E)** directive allows the user to simulate a single gaz-phase flow computation, it must be used in the *command block*. The default setting is OFF, implying standard two-phase flow computation. When the keyword GAZ is applied to a circuit, the liquid residual phase of its elements is considered in thermal and dynamic equilibrium with the gas phase i.e. saturation T of vapor, pressure and gas velocity. The void fraction is set to its maximum value  $1 - 10^{-6}$  and the volume levels are set to their residual value  $10^{-3}$ . No liquid mass, energy and momentum balances are computed for the corresponding elements.

The option GAZ may be activated either before any PERMITIT directive (and associated ones as REALC, REALAX...) of use in GOPERM, or anywhere else during the transient calculations after GOPERM.

When the option is activated, no water mass and/or energy and impulsion injections are allowed by SOURCE, PIQREV, PIQVANNE, PIQSOUP, PIQSEB, ACCU, BC3x, BC4y or BC5yy or CANDLEs. The use of REFLOOD or CCFL models are also forbidden.

The **MONOPHAS(E)** directive can be used several times for a same element or for different elements during a transient calculations. This, for instance, allows the user first to initialize a circuit CIRC1 under gas single phase flow condition (MONOPHASE circ1 GAZ), then to perform a stabilized transient under the same conditions, then to activate the two phase flow computation (MONOPHASE circ1 OFF) in order to take into account water injection.

### Associated Keywords

FLUID, CIRCUIT, REACTOR, PERMITIT, REALC, REALAX, MODEL, BCMOD

### Syntax

<b>MONOPHAS</b>	element or	<b>GAZ</b> <b>OFF</b> ;
-----------------	---------------	----------------------------

<b>elem</b>	: name of an element (reactor, circuit, axial, volume, bcondit, rg). If the element is a reactors, a circuit all the associated sub-components will have the same option except for those which are redefined using another MONOPHASE directive. A choice then has to be made between:
<b>GAZ</b>	: keyword to activate “single-phase-flow” computation
<b>OFF</b>	: keyword to activate “two phase flow” computation.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 387/851

### Examples

#### Activate single phase flow computation

MONOPHAS circ1 GAZ ;

#### Definition of Permit constraints

```
PERMINIT circ1 ...;
REALC Circ1_element ...;
PERMINIT Circ2...;
REALC Circ2_element ;
```

#### Perform a “single phase” computation for circ1 and standard two phase flow computation for circ2.

GOPERM Reactor ;

#### Transient single-phase computation for circ1 and 2 phase flow computation for circ2

TRANSIENT Reactor ;

#### Activation of two phase flow computation for circ1

MONOPHAS CIRC1 OFF ;

#### Transient 2 phase flow computation for circ1 and circ2

TRANSIENT Reactor ;

#### Single phase computation option is activated again

MONOPHAS circ1 GAZ ;

**N.B** : the FORTRAN subroutine called in PILOT is MONOPHAS: CALL MONOPHAS (III, CCC, \*9999)

III	INTEGER value =1 – Unused for the moment.
CCC(3)	CHARACTER*8 array :
	CCC(1) = Keyword GAZ or OFF

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 388/851

# 116

## NEQ OPERATOR

*Command block only : The NEQ operator compares two operands of INTEGER type. Non-Equal-to has to be used within a test. The test will be satisfied if the result is TRUE.*

### Associated Keywords

MATHEMATIC, TRIGONOMETRIC, ABSOLUTE, EXP, NEQ, AND, MAX, MIN, OR, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF

### Example

```

IF          ((TIME      <      1500.0)
AND         (IGCTA     NEQ      56));
IGCTA =    56;
TGCTA56 =  TIME ;
TRIC56 =   TRIC ;
COEFREG1=  0.05 ;
COEFREG2=  0.10 ;
TREG56 =   TIME      +      10.0 ;
ENDIF      ;
;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 389/851

117

## NEWDT OPERATOR

The **NEWDT** operator is used to obtain the next time step recommended by the transient computation. The variable supporting the result of NEWDT has to be defined as a **DOUBLE** variable in the *command block* of data deck. This operator is a compulsory data of the transient scenario.

### Associated Keywords

NEWTIME, TRANSIENT, TRANSENS, TRANFUEL

### Syntax

dt               =               **NEWDT;**

### Example

```

dt               =               1.d-5 ;
time             =             0. ;
REPEAT          block1        10 ;
                time           =              time           + dt ;
                TRANSIENT     circ1        time           dt ;
                dt             =             NEWDT ;
END             block1 ;

```

**Warning :** Contrary to the older **CATHARE2** version (before the V2.5 series), the local variable "dt" is automatically restored in restart calculations. The use of TABLE directive is then obsolescent and should be suppressed.

**NB :** The corresponding FORTRAN function invoked in PILOT.f is NEWDT : DT = NEWDT (ivstat) where ivstat is the error code

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 390/851</a>

# 118

## NEW\_SYNT DIRECTIVE

The **NEW\_SYNT directive**, in the *data block* or in the *command block*, is used to improve compatibility between GUITHARE and CATHARE.

The directive is used when a directive is not understood by GUITHARE released version because the directive syntax has changed since the GUITHARE version release.

The user must write NEW\_SYNT at the beginning of the command line so that the command line is only read by CATHARE. It must be preceded by a command line starting with OLD\_SYNT followed by the directive old syntax which can be read by GUITHARE.

### Associated Keywords

GUI\_DAT, NEW\_SYNTOLD\_SYNT

### Syntax

**Command line read by GUITHARE and ignored by CATHARE**

OLD\_SYNT ;

**Command line read by CATHARE and ignored by GUITHARE**

NEW\_SYNT ;

### Example

OLD_SYNT					
MY_INOX	=	MINTEMPS	0.D0	MAXTEMP	1440.D0
LAMBDA	2	13.54D0	1.571D-2		
RO	3	7.966D3	-0.442D0	-3.894D-5	
CP	5	4.395D2	7.177D-1	-1.93D-3	2.53D-6 -1.126D-9 ;

NEW_SYNT						
MY_INOX	=	MATERIAL	MINTEMPS	0.D0	MAXTEMP	1440.D0
LAMBDA	2	13.54D0	1.571D-2			
RO	3	7.966D3	-0.442D0	-3.894D-5		
CP	5	4.395D2	7.177D-1	-1.93D-3	2.53D-6 -1.126D-9 ;	

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 391/851

# 119

## NEWTIME OPERATOR

The **NEWTIME** operator is used to obtain the new simulated time calculated by the transient computation. The variable supporting the result of NEWTIME has to be defined as a **DOUBLE** variable in *command block* of data deck. The NEWTIME operator is a compulsory variable of the transient scenario as the simulated time is modified during a transient calculation.

### Associated Keywords

NEWDT, TRANSIENT, TRANSENS, TRANFUEL

### Syntax

```
time =      NEWTIME    ;
```

### Example

```
dt      =      1.D-5      ;
time   =      0.          ;
REPEAT block1      10      ;
      time   =      time      + dt ;
      TRANSIENT circ1      time      dt ;
      dt      =      NEWDT;
      time   =      NEWTIME ;
END      block1 ;
```

#### Case of a computation restart :

Contrary to older versions (before V25), the local variable “time” is automatically restored in restart calculations. The use of TABLE directive is then obsolete and should be suppressed.

**NB :** The corresponding FORTRAN function invoked in PILOT.f is NEWTIM : TIME = NEWTIM (ivstat) where ivstat is the error code

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 392/851

# 120

## NOFLOW DIRECTIVE

The **NOFLOW** directive is used after the PERMIT directive, in the *command block*. It is used to impose a no flow condition at a junction of an element for the initial state calculation (steady state).

### Associated Keywords

PERMIT, ECHPOWER, IMOSFLOW, LEVEL, GOPERM, REALC, REALVO, REALAX

### Syntax

**NOFLOW** elem1 junction1;

<b>elem1</b>	: element with a branch where a no flow condition
<b>junction1</b>	: junction where the NOFLOW condition is to applied

### Example

Assuming that GENVAPR is an element (an AXIAL for example) and TEXPANSR one of its junction (outlet of a TEE branch for example), the following syntax is correct:

NOFLOW genvapr texpansr ;

Refer to PERMIT operator for a global example of an initial state declaration.

**NB :** The corresponding FORTRAN subroutine called in PILOT is NOFLOW : Call NOFLOW(elem1, junc1,\*9999)

Elem1	Character8, name of the element
Junc1	Character8, name of the junction

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 393/851

121

## NONCOND OPERATOR

The **NONCOND** operator, used in *data block* only, defines the set of non-condensable gases handled by the two fluid model of **CATHARE**. It is specified during the construction of the circuit (see **CIRCUIT** operator).

*The maximum number of non-condensable gases is 4 .*

**BEWARE :** In case of 2 circuits, if a SGTR operator is connected during the calculation or if the circuits are implicitly coupled, the NONCOND operator has to be the same for both circuits. In other cases, each circuit can handle a different number of non-condensable gases.

Acquisition of non-condensable gases can be done only one time for two circuits if the same non-condensable gases are defined for the two circuits but they will have to be declared in the two circuit operators.

### Associated Keywords

RADCHEMI, CORE, CIRCUIT, REACTOR

### Syntax

```

incond=    NONCOND      ngas
           (VISC        STANDARD    or      WILKE )
           (COND        STANDARD    or      MASSAX
            or          AVERAGE    or      COEFQ
                           or      USER  )

           gasname_1   (POLYNCPT)
           gasname_2   (POLYNCPT)
           (( z1       ( z1a      z1b      z1c
             z1d       z1e      z1f ) )
             (z2)      (z3)      (z4)      (z5)
             (z6)      (z7)      (z8)      ((z9) ))
           gasname_ngas
           ((z1)      (z2)      (z3)      (z4)
             (z5)      (z6)      (z7)      (z8)      ((z9))) ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 394/851

<b>Incond</b> <b>NONCOND ngas</b> <b>VISC STANDARD</b> or <b>WILKE</b> <b>COND STANDARD</b> or <b>MASSAX</b> <b>or AVERAGE</b> <b>COEFQ q</b> or <b>USER</b>	: name of the non-condensable gas list. : keyword followed by an integer > 0 and equal to the total number of non-condensable gases expected in the circuit (1, 2, 3 or 4). : OPTIONAL keyword specifying the gas mixture viscosity model : arithmetic mean of viscosities (weighted by molar fractions) (default model when <b>VISC</b> keyword is not used)  : Wilke's model : OPTIONAL keyword specifying the gas mixture conductivity model : arithmetic mean of conductivities (weighted by molar fractions) (default model when <b>COND</b> keyword is not used)  : Mason and Saxena's model : average based on both arithmetic and geometric means of conductivities (weighted by molar fractions) : constant weighting coefficient  : weighting coefficient as a function of mass (or molar) fractions (specified by the user in FHQUSER.f subroutine)	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>gasname_i</b> <b>NITROGEN</b> or <b>HYDROGEN</b> or <b>HELIUM</b> or <b>OXYGEN</b> or <b>ARGON</b> or <b>AIR</b>	: keyword that may have any of the following values : : the non-condensable gas is nitrogen : the non-condensable gas is hydrogen : the non-condensable gas is helium : the non-condensable gas is oxygen. : the non-condensable gas is argon : the non-condensable gas is air	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>POLYNCPT</b>  or <b>OTHERGAS</b> <b>Or XXXXXXXX1</b> <b>Or XXXXXXXX2</b> <b>Or XXXXXXXX3</b> <b>Or XXXXXXXX4</b> <b>POLYNCPT</b>	: OPTIONAL keyword to use polynomial pre-defined function CP(T) <b>NB</b> : For these predefined gases, the keyword is not followed by any real parameter because the gas characteristics are already defined in CATHARE.  : non-condensable gas not predefined in CATHARE2. The name (XXXXXXXi) (character*8 chosen by the user) must be followed by a list of nine real numbers characterizing the physical properties of the gas (z1 to z9)	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>z1</b>  <b>(and z1a, z1b, z1c, z1d, z1e, z1f)</b>  <b>z2</b>	: OPTIONAL keyword to define <i>Cp</i> as a polynomial function of <i>T<sub>k</sub></i> ( <i>T<sub>k</sub></i> in Kelvin). It requires the definition of a list of real values (z1 to z1f) as defined below : specific heat at constant pressure, real value > 0 to define <i>Cp</i> as a constant value <i>Cp</i> = z1 (J/kg/K). : OPTIONAL list of real values to define the specific heat <i>Cp</i> as follows: $Cp = z1 + z1aT_k + z1bT_k^2 + z1cT_k^3 + z1dT_k^4 + z1eT_k^5 + z1f * T_k^6$ with <i>T<sub>k</sub></i> in Kelvin It has to be preceded by POLYNCPT as explained just above. : molar mass (g/mol).	<b>To be re- peated as many times as needed</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 395/851

- z3, z4, z5** : list of real coefficients to describe the dynamic viscosity variation with respect to the absolute temperature ( $T_k$  in Kelvin) as follow:  
 $\mu = z3T_k^2 + z4T_k + z5$  ( $\mu$  in kg/m/s)
- z6, z7, z8** : list of real coefficients to describe the thermal conductivity variation with respect to the absolute temperature ( $T_k$  in Kelvin) as follow:  
 $\lambda = z6T_k^2 + z7T_k + z8$  ( $\lambda$  in W/m/K)
- z9** : volume molecular diffusion.

**NB :** In other directives, the first non-condensable gas is called X1 (or X1EXT) , the second one X2 (or X2EXT) ...

### Examples

- 1)  
i1 =            NONCOND      1                    NITROGEN      ;
- 2)  
i2=            NONCOND      3  
OTHERGAS      1056.0  
28.  
-9.D-12        0.44D-8      5.D-6  
-14.D-9        7.D-5          7.D-5          5.D-3  
HYDROGEN  
NITROGEN      POLYNCPT      ;
- 3)  
i3=            NONCOND      3  
XXXXXXX1      1056.0  
28.  
-9.D-12        0.44D-8      5.D-6  
-14.D-9        7.D-5          7.D-5          5.D-3  
XXXXXXX2      POLYNCPT      31.15  
2.68e-5  
0.D0 -         1.357e-2  
-1.168e-8  
0.D0 0.D0  
28.  
-9.D-12        0.44D-8      5.D-6  
-14.D-9        7.D-5          7.D-5          5.D-3  
AIR              ;
- 4)  
i4=            NONCOND      2  
VISC            WILKE  
COND            AVERAGE      COEFQ      0.5  
HELIUM  
NITROGEN      ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 396/851

122

## OLD\_SYNT DIRECTIVE

The **OLD\_SYNT directive**, is used when a directive is not understood by GUTHARE released version because the directive syntax has changed since the GUTHARE version release.

The user must write OLD\_SYNT at the beginning of the command line compatible with GUTHARE version so that the command line is only read by GUTHARE. This line must be followed by a command line starting with NEW\_SYNT which is read by CATHARE available version.

### Associated Keywords

NEW\_SYNT, OLD\_SYNT, GUI\_DAT

### Syntax

**Command line read by GUTHARE and ignored by CATHARE**

OLD\_SYNT ;

**Command line read by CATHARE and ignored by GUTHARE**

NEW\_SYNT ;

### Example

```

OLD_SYNT
MY_INOX=    MINTEMPS   0.D0        MAXTEMP   1440.D0
LAMBDA     2            13.54D0    1.571D-2
RO         3            7.966D3   -0.442D0   -3.894D-5
CP         5            4.395D2   7.177D-1   -1.93D-3      2.53D-6   -1.126D-9 ;
*
NEW_SYNT
MY_INOX=    MATERIAL    MINTEMPS   0.D0        MAXTEMP   1440.D0
LAMBDA     2            13.54D0    1.571D-2
RO         3            7.966D3   -0.442D0   -3.894D-5
CP         5            4.395D2   7.177D-1   -1.93D-3      2.53D-6   -1.126D-9 ;

```

DE LA RECHERCHE À L'INDUSTRIE 		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 397/851

123

## OPENALL DIRECTIVE

In the *command block* only.

The **OPENALL** directive is used in the *command block* to connect all sinks and sources defined in the V25\_3.INIT.

It deals with each of the following gadgets: **PIQREV, SOURCE, BREAK, PIQBREK, SINK, PIQSEB, PIQSOUP, PIQVANNE, PIQARE, SINKRRI, SOURIS**.

### Associated Keywords

**PIQREV, SOURCE, BREAK, PIQBREK, SINK, PIQSEB, PIQSOUP, PIQVANNE, PIQARE, SINKRRI, SOURIS.**

### Syntax

**OPENALL** ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 398/851

124

## OPENBREK DIRECTIVE

With the OPENBREK directive to be used *in the command block* only, an **PIQBREK** or **SGTR** object which was defined in the data block is informatically connected to the element. It can be calculated by **CATHARE**.

### Associated Keywords

PIQBREK, SGTR, CLOSE

### 124.1 OPENBREK for a PIQBREK in an AXIAL element

#### Syntax

<b>OPENBREK</b>	brec	<b>NODE</b>	ip	<b>SECTBREC</b>	z2 ;
		<b>DTOPEN</b>	z1		

<b>brec</b>	: piqbrek name.
<b>NODE</b> ip	: keyword followed by the scalar point of the meshing of the pipe.
<b>DTOPEN</b> z1	: keyword followed by a real number >0 defining the opening delay (s) (default value is 0.).
<b>SECTBREC</b> z2	: keyword followed by a real number $0 \leq z2 \leq 1$ to define the opening. It is defined as the ratio of the opening cross-section on the maximum cross-section which is defined in the break definition (data block).
	<b>NB</b> : for a piqbrek, the opening cross-section has to be equal to the maximum cross-section defined in the data block (z2=1.0).

**Warning** : the outside pressure should have been defined through CCV before connecting the PIQBREK

#### Example

*In the data block*

sbrkm =	1.D-2				
BREAK1 =	PIQBREK	AXIAL	tube1		
	SECT	sbrkm	lengtht	0.0	;

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 399/851</a>

Opening cross section =  $10^{-3}$   $\Rightarrow shrk1 = \frac{10^{-3}}{sbrkm} \Rightarrow sbrk1 = 0.1$

In the command block

```
OPENBREK    break1      NODE      10
            DTOPEN     0.0       SECTBREC   sbrk1      ;
```

## 124.2 OPENBREK for a PIQBREK in a VOLUME element

### Syntax

```
OPENBREK    brec      TXELEV    z1
            DTOPEN     z2       SECTBREC   z3      ;
```

<b>brec</b>	: piqbrek name.
<b>TXELEV</b> <b>z1</b>	: keyword followed by a real number $0 \leq z1 \leq 1$ defining the relative elevation of the piqbrek from the bottom of the volume (m).
<b>DTOPEN</b> <b>z2</b>	: keyword followed by a real number $>0$ defining the opening delay (s) (default value is 0.)
<b>SECTBREC</b> <b>z3</b>	: keyword followed by a real number $0 \leq z3 \leq 1$ . It is defined as the ratio of the opening cross-section on the maximum cross-section defined in the break definition (data block).
<b>NB</b> : for a piqbrek, the opening cross-section has to be equal to the maximum cross-section defined in the data block ( $z3 = 1.0$ ).	

**Warning** : the outside pressure should have been defined through CCV before connecting the PIQBREK.

### Example

```
OPENBREK    breakpressu  TXELEV    0.99
            DTOPEN     0.        SECTBREC   1.D0      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 400/851

## 124.3 OPENBREK for a SGTR

### Syntax

```
OPENBREK brec      NODE          ip
DTOPEN    z1       SECTBREC   z2
              ;
```

<b>brec</b>	: sgtr name
<b>NODE</b> ip	: keyword followed by the scalar point of the meshing of the pipe on the primary side (if in data block, there is only one point defined – option UNIQ – ip may be replaced by 0)
<b>DTOPEN</b> z1	: keyword followed by a real number >0 defining the opening delay (s)
<b>SECTBREC</b> z2	: keyword followed by a real number $0 \leq z2 \leq 1$ . It is defined as the ratio of the opening cross-section on the maximum cross-section defined in the break definition(data block)
.	

### Example

```
OPENBREK SGTR1      NODE          10
          DTOPEN      0.           SECTBREC   1.D0
          ;
```

**NB :** The corresponding FORTRAN subroutine is OUVRIR : CALL OUVRIR ( OBJDIR, CTYPE, 3, 1, 3, CVAL , IVAL , RVAL, \*9999)

<b>OBJDIR</b>	: array of character*8 words containing the piqbrek name
<b>CTYPE</b>	: array of character*8 words containing any value for it is not used
<b>CVAL</b>	: array of 3 CHARACTER*8 variables
	CVAL(1) = 'NODE ' or 'TXELEV '
	CVAL(2) = 'DTOPEN '
	CVAL(3) = 'SECTBREC'
<b>IVAL</b>	: Integer equal to the node number (if NODE keyword was used) , equal to 0 else
<b>RVAL</b>	: array of 3 real numbers
	RVAL(1) = elevation of the piqbrek if TXELEV keyword was used, 0. else
	RVAL(2) = value of DTOPEN
	RVAL(3) = value of SECTBREC

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 401/851</a>

125

## OPEN DIRECTIVE

*In the command block only.*

With the OPEN directive, an object which was defined in the data block is informatically to the circuit (or element). It can be calculated by CATHARE.

**NB :**

1. In case of an (0D) accumulator, ACCU, this command must be used only for reopening an accumulator previously closed by the CLOSE directive.

### Associated Keywords

CLOSE, ACCU, OPENALL

### Syntax

**OPEN**            item            ;

**item** : name of the gadget to connect. It can be of the following type : ACCU. The other gadgets activation is controlled by ENABLE/DISABLE directives

### Example

Assuming soustabr is an external source

```
WRITE      50.          LIQFLOW    soustabr      ;  
WRITE      100.0        LIQTEMP    soustabr      ;  
OPEN       soustabr     ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 402/851

**NB :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR : CALL OUVRIR ( CVAL , NVAL, \*)

NVAL	INTEGER number of objects to be connected
CVAL(NVAL)	CHARACTER*8 array names of the objects.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 403/851

# 126

## OPENFILE OPERATOR

The **OPENFILE** operator allows the user opening a personal file (formatted or not). It is used in the *command block*.  
**Warning :** the personal file cannot be a **CATHARE** file.

### Associated Keywords

**INTERP**, **READHEAD**, **READVAR**, **REWIND**, **WRITHEAD**, **WRITVAR**

### Syntax

NUNITE=      **OPENFILE**      'filename'      **BINARY**      (or      **FORMAT**)      ;

**filename**      : name of the personal file (created if not existing).  
**BINARY**      : keyword indicating that the file will be opened in binary (respectively formatted) form.  
**or FORMAT**

### Example

NUNITE=      **OPENFILE**      'FORT10'      **BINARY**      ;

**N.B** : the FORTRAN function called in PILOT is OPENFILE : NUNITE = OPENFILE (FNAME, FORMA, IVSTAT)

**FNAME**      CHARACTER\*16 file name  
**FORMA**      CHARACTER\*8 : 'FORMAT' or 'BINARY'  
**IVSTAT**      Returned error code

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 404/851

# 127

## OPTION DIRECTIVE

This directive is used to define the general computational or input-output options, in the *command block*.

### Associated Keywords

**VERBOSE, RESETIME, RESTORE, SAVE, INISIM, MANAGE, FASTSIZE**

### Syntax

#### OPTION

	<b>(DTMAX</b>	dtmax)		
or	<b>(DTMIN</b>	dtmin)		
or	<b>(GRIDS</b>	ni)		
or	<b>(IMPI</b>	iimpi)		
or	<b>(ITERMIN</b>	imin)		
or	<b>(MAXREP</b>	maxrep)		
or	<b>(NCPUSAV</b>	ni)		
or	<b>(PARALLEL</b>	<b>OFF</b>		
	or	<b>SIMPLE</b>		
	or	<b>PAQUET</b>	)	
or	<b>(PARALLEL</b>	<b>(SOLVER</b>		
	or	<b>ALL</b>	ctree	
	<b>REACTOR</b>	or	ccir1	ccir2 )
or	<b>(ROCP</b>	corocp)		
or	<b>(REGUL</b>	<b>ON</b>	or	<b>OFF</b> )
or	<b>(NUSSELT</b>			
or	<b>(HISTORY</b>	ihist)	;	

**DTMAX** : OPTIONAL keyword followed by a real number > 0., maximum authorized time step  
**dtmax** (default value: 1000 s).

**DTMIN** : OPTIONAL keyword followed by a real number > 0. representing the minimum time step (default and restricted values are: :  $10^{-5}$  s and  $10^{-10}$  s).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>GRIDS</b> <b>ni</b>	<b>Document technique DEN</b>	<a href="#">Page 405/851</a>

<b>HISTORY</b> <b>ihist</b>	: OPTIONAL keyword followed by an integer (0 or 1), default value : <i>ihist</i> = 0). 1 means that commands used in PILOT are written into V25_3.HIST file 0 means no writing.
<b>IMPI</b> <b>iimpi</b>	: OPTIONAL keyword followed by an integer < 0 or 0 or 1. Flag to print out the convergence state of modules that did not converge ( <i>iimpi</i> = 1). Default value : 0 for no printouts). If <i>iimpi</i> = $-n < 0$ , printout indicates the number of iterations for each element whose number of iteration for convergence is greater than <i>n</i> .
<b>ITERMIN</b> <b>imin</b>	: OPTIONAL keyword followed by an integer $> 0$ to impose imin NEWTON iterations in all NEWTON processes of <b>CATHARE</b> .
<b>MAXREP</b> <b>maxrep</b>	: OPTIONAL keyword followed by an integer $> 0$ representing the maximum number of successive time step decreases during one time step.
<b>NCPUSAV</b> <b>ni</b>	: OPTIONAL keyword followed by an integer ( <i>ni</i> = 0, 1 or 2, default value is <i>ni</i> = 0). When two calculations are expected to produce the same result, the cpu time is the only value which may change. This option allows the binary comparison of “save” or “result” files by hiding the value of the cputime: <i>ni</i> = 1: in the V25_3RESTART files (FORT8*), the cputime is set to 0.0. <i>ni</i> = 2: in the RESULT file FORT21, the cputime is set to 0.0 and real numbers are written in double precision format (64 bits) (else, they are written in single precision).
<b>PARALLEL OFF</b> <b>or SIMPLE</b> <b>or PAQUET</b>	: OPTIONAL keyword. This option activates different levels of the OMP parallel computing : <b>OFF</b> : this keyword is the default value for which no parallelism is active <b>SIMPLE</b> : this keyword activates the concurrent calculation of hydraulic elements (PGTHYDR is run instead of GTHYDR) <b>PAQUET</b> : with keyword PAQUET, it better balances the charge of calculation in PGTHYDR spreading the hydraulic elements equally on the available processors. <b>CATHARE</b> uses the information of a previous calculation (see directive PESEE).  <b>Warning</b> : This option must be placed before the RESTORE directive in the input deck (see example)
<b>PARALLEL SOLVER</b> <b>cmtree or ALL</b> <b>cmtree</b>	: OPTIONAL keyword. In case of OMP parallel computing, one can improve the speed-up of the <b>CATHARE</b> solver by imposing a better order to eliminate the elements in the junction system. The calculation of this order is not automatic, the order of the elements must be established by the user (see the user’s manual) and written in a user’s subroutine. In the following, the improved order of elimination is called “ <i>a tree</i> ”.
<b>SOLVER</b> <b>ALL</b>	: if this keyword is used, it means that the optimisation is done only for the <b>CATHARE</b> solver. For the loop on the elements the option SIMPLE is taken (see above).
<b>cmtree</b>	: if this keyword is used, it means that the optimisation is done for the <b>CATHARE</b> solver and in addition the option PAQUET is taken to optimise the loop on the elements (see above).
	: keyword giving the order of the elements for an improved elimination:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 406/851

- for the SCAR data set, predefined data are put in private subroutines : several values of *ctree* are available (*ctree* = CP1, CP1RRA, CP1RRATH, N4, N4RRA, N4RRATH and the corresponding subroutines are SGCP1.f, SGCP1RRA.f, SGCP1RRATH.f, SGN4.f, SGN4RRA.f and SGN4RRATH.f).
- for the EPR data set, predefined data are put in the subroutine SGEPRTH.f and the corresponding *ctree* is EPRTH.
- SOFIA simulator data set, DPY, DPYRRA, DPYRRATH, FA3, FA3TH, FA3RRA and FA3RRATH values of *ctree* are available but the data must be implemented by user in the corresponding subroutines (SGDPY.f, SGDPYRRA.f, SGDPYRRATH.f, SGFA3.f, SGFA3TH.f, SGFA3RRA.f and SGFA3RRATH.f).
- for the other data sets, the user must fill the subroutine SGUSERREAC.f and use *ctree* = USER.

**REACTOR  
or ccir1 ccirc2**

**REACTOR** : keyword to use when there is one solver only (the heat exchanger between primary and secondary circuits are defined as implicit). This must be used for SCAR data sets.

**ccir1 ccirc2** : if there is one solver for the primary circuit and one solver for the secondary circuit (the heat exchanger between primary and secondary circuits are defined as explicit), the names of both circuits must be given. In this case, two “trees” must be calculated and they are given in subroutines SGUSERC1.f and SGUSERC2.f.

**Warning** : This option must be placed before the RESTORE directive in the input deck (see example)

**ROCP  
corocp**

: OPTIONAL keyword followed by a real number > 0., coefficient which divides the heat capacity of the walls. This directive may be used during the calculation to accelerate the control command transient convergency. **Advisable value** = 100. (default value : *corocp* = 1)

**NB** : In revision 6 or 6.1, the value 1.D6 should be avoided because of rough consequences due to Chen correlation.

**REGUL ON**

: OPTIONAL keyword followed by ON ; it must be used before the control command block if time is increasing during this stabilized transient. ON activates the upholding of enthalpy at saturation in the pressurizer

note#1 : the pressurizer has to be defined with the PRSRIZER keyword in the VOLUME operator.

note#2 : if *time* = 0. during this stabilized transient this option is automatically enabled.

**REGUL OFF**

: OPTIONAL keyword followed by OFF must be used after the control command block to disable options for the pressurizer calculations. **After OPTION REGUL OFF, the RESETIME directive must be used.**

**NUSSELT**

: OPTIONAL keyword to use a different nusselt number in the (*q<sub>pg</sub>*) wall to gas heat flux

**Remark**

: The whole set of options are **saved** in the restart file **except for PARALL**. They keep their default or reflected values through subsequent runs or they can be redefined at any stage in the calculation process.

**N.B** : the FORTRAN subroutine called in PILOT is OPTIOP: Call OPTIOP ( III, DDD, CCC, COPTIO, \*9999 )

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 407/851

III DDD CCC COPTIO *9999	INTEGER value of the option COPTIO DOUBLE PRECISION value of the option COPTIO CHARACTER*8 value of the option COPTIO CHARACTER*8 name of the OPTION fatal error treatment
--------------------------------------	--

### Example

Using the PARALLEL option :

1. In the first calculation (steady state + transient), the option PARALLEL SOLVER is requested. During the transient, the directive PESEE allows to calculate the cpu time used by each element. The values are stored by CATHARE : they can be used in a next calculation with the option PARALLEL ALL. The directive PERF ON allows the start of the measures of performances. PERF OFF stops the measures. With the directive PRINSTRU, the frequency of the writing of the measures of performances is given.

```

OPTION      PARALLEL    SOLVER      CP1RRA      REACTOR;
RESTORE ;
...
GOPERM ;
...
PERF        ON ;
PRINSTRU    NSTEP       10 ;
PESEE        ON ;
( Bloc      TRANSIENT   )
PESEE        OFF ;
PERF        OFF ;
SAVE        n ;
END         EXEC ;

```

2. The following calculation is done with a better level of optimization (PARALLEL ALL)

```

OPTION      ALL          CP1RRA      REACTOR;
PARALLEL
RESTORE    n ;
...
( Bloc      TRANSIENT   )
SAVE        p ;
END         EXEC ;

```

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 408/851

# 128

## OR OPERATOR

The **OR** operator has to be used within a test in the *command block* only. It has the same behaviour as in the FORTRAN language. It performs a logical inclusive disjunction between two operands.

### Associated Keywords

REPEAT, END, IF, ENDIF, ELSE, QUIT, AND, OR

### Example

```
IF ( TIME      >      150.0
      OR        INDIC      EQ      0 ) ;
      QUIT      BLOC1      ;
ENDIF      ;
```

 <b>ce</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 409/851

129

## OXRATE DIRECTIVE

The **OXRATE** directive, in *command block*, enables the user to carry out a parallel calculation of the oxidation rate for a fuelchar, with respect to an oxidation kinetics law that can be specified.

It becomes effective when called.

### Associated Keywords

FUELCHAR, SPALL, SPALLECR, SPALLOX

### Syntax

**OXRATE**      fuelchar1      **OXNAME**      ;

**fuelchar1**      : name of the fuelchar element for which the oxidation rate is calculated

<b>OXNAME</b>	: keyword used to specify the specific oxidation law to be used :
<b>STANDARD</b>	: the <b>CATHARE</b> Standard Cathcart-Pawell law is used for the calculation
<b>CATHCART</b>	: the Cathcart-Pawell law describing total oxygen consumption is used for the calculation
<b>BAKERJUS</b>	: the Baker-Just law is used for the calculation

**NB1** : It calculates the oxidation rate independently, which means that the **CATHARE** calculation is not modified by this option.

### Example

```
OXRATE    CARMOY    STANDARD    ;
or
OXRATE    CARMOY    CATHCART   ;
or
OXRATE    CARMOY    BAKERJUS  ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 410/851

**NB2** : the FORTRAN subroutine called in PILOT is OXRATE: CALL OXRATE ( OBJNAM, OXNAM, \*9999)

OBJNAM	CHARACTER*8 name of the fuelchar for which the oxidation rate is calculated.
OXNAM	CHARACTER*8 name of the oxidation law used

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 411/851</a>

130

## PCAVIT DIRECTIVE

The **PCAVIT** directive is used, in the *command block*, to stop or reactivate the cavitation model of a **PUMPCHAR** object.

### Associated Keywords

**PUMPCHAR**, **BLKROTOR**, **PUMPMOD**, **STOPPUMP**, **STARPU**

### Syntax

```
PCAVIT      char      ON          ;
or
PCAVIT      char      OFF         ;
```

**char** : name of the pumpchar object where the cavitation model has to be changed.  
**OFF** : keywords used respectively to stop or reactivate the calculation of the cavitation model.  
**ON**

**NB1 :**

1. To stop the cavitation model on a pump, it must have been declared first in the pump definition (see **PUMPCHAR** operator, **CAVITANT** keyword).
2. To reactivate the cavitation model on a pump, it must have been stopped previously in the command block.

### Example

```
PCAVIT      carpom1    OFF        ;
PCAVIT      carpom1    ON         ;
```

**NB** : The corresponding FORTRAN subroutine called in PILOT is **PCAVIT** :  
`CALL PCAVIT (OBJNAM, ISGOPT, *9999)`

**OBJNAM** : character\*8 variable equal to the name of the pumpchar object  
**ISGOPT** : integer equal to 1 if ON keyword is used or 0 if OFF.

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 412/851

# 131

## PERF DIRECTIVE

The **PERF** directive enables the user to start or stop the CPU time performances measurement, in *command block* after RESTORE directive. The printing of these measurements is managed by the PRINSTRU directive.

The **PERF** directive can be used several times during a computation, but the user must stop the measurements before starting again.

### Associated Keywords

OPTION, PESEE, PRINSTRU

### Syntax

**PERF**           **ON**           ;  
or               **OFF**           ;

**ON**               : start the measurement of performances.  
**OFF**              : stop the measurement of performances.

If **PERF** and **PESEE** directives are used together, the option **PERF OFF** must be used after the option **PESEE OFF**. See example in OPTION directive.

**N.B** : the FORTRAN subroutine called in PILOT is **PERF: CALL PERF (LALIDENH, OOW(1), OOW(2), \*9999)**

<b>LALIDENH</b>	Pointer on structure ALIDENH
<b>OOW(1)</b>	CHARACTER*8 : 'PERF'
<b>OOW(2)</b>	CHARACTER*8 value for PERF : 'ON' or 'OFF'

132

## **PERIOD DIRECTIVE**

The **PERIOD** directive enables the user to initialize or modify printouts of computation results, in *command block*. Each element has its own printout frequency. The default value is 0 (no printout for the element). If a radio chemical calculation is performed in the element, the results are printed with the same frequency.

The **PERIOD** directive can be used several times for a same element during a computation.

### **Associated Keywords**

LIST IMPRIME MESSAGE TITLE PRIN3D SAVE RESULT

## Syntax

<b>PERIOD</b>	elem	(GROUP )
		(ALL)
	or	(XJUNCTX)
		SECOND
	or	NSTEP
		s ;
		n ;

**elem** : name of an element (reactor, circuit, catafuel, axial, volume, threed, bcondit, rg, core or hydimp). If the element is a reactor, a circuit or a catafuel, all its sub-components will have the same printout frequency except the ones for which the frequency is redefined by another PERIOD directive.

If the element (axial or bcondit) is of type **GROUP**, it must be followed by the keyword **GROUP**. In that case, all the elements of the group are printed.

A choice then has to be made between the following :

**ALL** : OPTIONAL keyword to print all the printouts of the element (default value). elem must be a reactor, a circuit or a catalyse.

**XJUNCTX** : OPTIONAL keyword to print exclusively junctions printouts. elem must be a reactor, a circuit or a catafuel.

: keyword followed by a real number  $> 0$ .

**s** : printout frequency in second.

: keyword followed by an integer  $\geq 0$ .

**n**: printout frequency in step number.

• Frequency in step function

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 414/851

<b>Examples</b>
-----------------

```

PERIOD    circ1      NSTEP      7 ;
PERIOD    circ3      XJUNCTX   SECOND     10. ;
PERIOD    downcomi   SECOND     1. ;
PERIOD    catal1     NSTEP      10 ;
PERIOD    hydimp1   SECOND     1. ;

PERIOD    cana       GROUP      SECOND     1. ;

```

In the last example, we assume that cana is an **AXIAL GROUP** element.

**N.B** : the FORTRAN subroutine called in PILOT is PERIOD: CALL PERIOD (III, FFF, CCC, \*9999)

III	INTEGER value for NSTEP
FFF	DOUBLE PRECISION value for SECOND
CCC(3)	CHARACTER*8 array : if ALL and XJUNCTX were not used CCC(1) = Name of the object CCC(2) = Keyword NSTEP or SECOND CCC(3) not used else (case of ALL or XJUNCTX) CCC(1) = Name of the object CCC(2) = Keyword ALL or XJUNCTX CCC(3) = Keyword NSTEP or SECOND

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 415/851

# 133

## PERMIT DIRECTIVE

The **PERMIT** directive of the *command block* is used to give the order of the elements of each circuit during the initial state calculation of the system.

**PERMIT** must be followed by **REALC**, **REALAX** or **REALVO** directives. It can also be followed by optional directives, such as : **NOFLOW**, **IMOSFLOW**, **LEVEL**, **ECHPOWER**, **GVPOWER**, **TPER3D** and **ADIABWAL**.

**Remark for CATHARE2 V2.5 versions:** Remember that Tees are not elements in the present version, so do not put Tee in the list of elements.

The Boundary Condition elements must be at the end of the element list, after axial, volume or 3d types.

In case of a 2 circuits reactor, the first **PERMIT** must deal with the primary circuit, the second **PERMIT** must deal with the secondary circuit.

### Associated Keywords

**ECHPOWER**, **GOPERM**, **IMOSFLOW**, **LEVEL**, **NOFLOW**, **REALC**, **REALVO**, **REALAX**, **GVPOWER**, **TPERTR**, **ADIABWAL**, **MONOPHAS(E)**, **ROCPELEM**, **TPERTR**

### Syntax

```

PERMIT circ1
      elem1      elem2      (GROUP)      ...
      (DEADZONE zone1      zelem11     ...      zelem1p )
      (DEADZONE zone2      zelem21     ( junc1    valv1 ) )
      (DEADZONE zone3      zelem31     ( valv2    valv3 ) )

```

**circ1** : circuit name

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 416/851</a>

<b>elem1 ... elemn</b>	: list of the elements of the circuit. The elements must appear in a specific order to comply with the following rules: - <b>REALC</b> defines the initialization values of the first element - elements are initialized one by one by receiving on upstream junction(s) the initial data coming from adjacent(s) element(s) - if one upstream junction of the element is not connected to a previous initialized element, a new <b>REALC</b> constraint has to be defined - if an element cannot receive data from previous element, a <b>REALC</b> constraint has to be defined - the elements belonging to a DEADZONE must be outside this list, just after the <b>DEADZONE</b> keyword
<b>GROUP</b>	: If an element (axial or bcondit) is of type <b>GROUP</b> , it must be followed by the keyword <b>GROUP</b> . In that case, all the elements of the group are taken into account to compute the initial state.
<b>DEADZONE</b>	: OPTIONAL keyword that indicates a DEADZONE will be defined. A DEADZONE is a part of the circuit isolated by closed valves (CONTROL VALVE). A DEADZONE can be bounded in three ways : - Case 1 : the DEADZONE is a set of elements and is bounded by control valves positioned at junctions. In this case only the list of elements must be specified (see zone <i>zrhr1</i> in example 4) ; - Case 2 : the DEADZONE contains elements and a portion of an axial element bounded at one end by a junction and at the other end by a control valve positioned on an internal vector node (see zone <i>zacc11</i> in example 3 or <i>zone1</i> in example5) ; - Case 3 : the DEADZONE is a portion of an axial element bounded by 2 control valves positioned on vector nodes node (see zone <i>zacc12</i> in example 4).
<b>zonej</b>	: name of the DEADZONE
<b>zelemxx</b>	: name of the elements of the zone in the order of their initialization
<b>junc1 valv1</b>	: case of a DEADZONE composed of a portion of an axial element delimited by junction <b>junc1</b> and valve <b>valv1</b>
<b>valv1 valv2</b>	: case of a DEADZONE composed of a portion of an axial element delimited by valve <b>valv2</b> and valve <b>valv3</b>

### Example 1

1. List of the elements of the primary circuit (BRECHE is a BCONDIT element) :

<b>PERMINIT</b>	CIRC1			
	VOLINF	BYPASS	COEURMOY	PLENSUP
	GENVAPI	GENVAPR		
	EXPANS	PRESSU		
	TUYBRK			
	VOLDOWN	DOWNCO	COUVE	
	BRECHE ;			

2. The level is imposed in the volume PRESSU :

**LEVEL**      PRESSU      7.32 ;

3. NOFLOW conditions on the junctions on element GENVAPR (TEE for the pressurizer line and TEE for the break)

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 417/851

:

**NOFLOW** GENVAPR TEXPANSR ;  
**NOFLOW** GENVAPR FR3 ;

4. Flow distribution for out coming junctions of volumes:

<b>IMPOSFLOW</b> VOLINF	<b>BYPASINF</b>	0.0469109	<b>MOYINF</b>	0.9530891 ;
<b>IMPOSFLOW</b> PLENSUP	<b>SUPROMPU</b>	0.333310	<b>SUPINTAC</b>	0.666690 ;
<b>IMPOSFLOW</b> VOLDOWN	<b>DOWNCOUV</b>	0.0201713	<b>DOWNDOWN</b>	0.9798287 ;

5. Data are given for the incoming junction DOWNFOND of VOLINF and for the incoming junction GUIDCOUV of PLENSUP : the other values everywhere in the primary circuit will be calculated from these data.

<b>REALC</b>	<b>DOWNFOND</b>	<b>P</b>	161.276D5	
	<b>HL</b>		1230.261D3	
	<b>HVSAT</b>			
	<b>ALFA</b>		1.D-5	
	<b>VL</b>		5.312	
	<b>VV</b>		5.312	
	<b>GUIDCOUV</b>	<b>P</b>		159.092D5
		<b>HL</b>		1230.227D3
<b>HVSAT</b>				
<b>ALFA</b>			1.D-5	
<b>VL</b>			.238	
<b>VV</b>			.238 ;	

6. Then, in the same manner, data are given for the secondary circuit :

**PERMINIT** CIRC2  
 ...

7. The exchanged power is given (ECHI and ECHR are the heat exchangers) :

**ECHPOWER** ECHI 927.D6 ;  
**ECHPOWER** ECHR 927.D6 ;

8. The initial state will be calculated :

**GOPERM** ;

### Example 2

In this example of PERMINIT directive, we assume that CANA, CANB are **AXIAL GROUP** elements and ENTA, ENTB are **BCONDIT GROUP** elements.

**PERMINIT** CIRC1  
**VOLINF** BYPASS COEURMOY PLENSUP

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 418/851

GENVAPI	GENVAPR		
EXPANS	PRESSU		
TUYBRK			
VOLDOWN	DOWNCO	COUVE	
CANA	<b>GROUP</b>	CANB	<b>GROUP</b>
BRECHE			
ENTA	<b>GROUP</b>	ENTB	<b>GROUP</b>
SORA	SORB	;	
*			
REALC	BOTA	GROUP	
		P	157.52299D5
		TL	280.04D0
		HVSAT	
		ALFA	1.0D-5
		VL	4.564D0
		VV	4.564D0 ;
*			
REALC	BOTB	GROUP	
		P	157.77883D5
		TL	280.04D0
		HVSAT	
		ALFA	1.0D-5
		VL	0.4569D0
		VV	0.4569D0 ;
<b>GOPERM</b>		;	

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 419/851

### Example 3

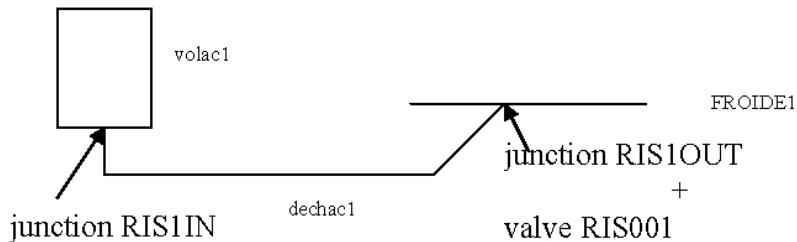


Figure 133.0.1: PERMIT : Example 3: One DEADZONE for accumulator

In this example, the accumulator 1 is represented by a volume VOLAC1 and an axial element DECHAC1. These two elements belong to the primary circuit.

There is a control valve RIS001 at the junction RIS1OUT between DECHAC1 and the cold leg FROIDE1. The valve RIS001 is closed (PU = 0.).

A DEADZONE must be defined for the accumulator :

```

PERMIT      CIRCP
...
DEADZONE   ZACC1
              VOLAC1    DECHAC1    RIS1IN    RIS001
              ...        ;

```

A NOFLOW condition is imposed on each side of junction RISOUT:

```

NOFLOW     DECHAC1    RIS1OUT;
NOFLOW     FROIDE1   RIS1OUT;

```

The level is imposed in VOLAC1:

```

LEVEL       VOLAC1    3.35;

```

Data are given in VOLAC1 for the initialization of VOLAC1 and DECHAC1:

```

REALVO     VOLAC1    LIQUID
                           TL      50.D0

```

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 420/851

	HVSAT	
X1	1.0D-7	
X2	1.0D-7	
X3	1.0D-7	
GAS		
P	42.8D5	
HLSAT		
TV	51.0	
X1	0.999999	
X2	1.0D-7	
X3	1.0D-7	

#### Example 4

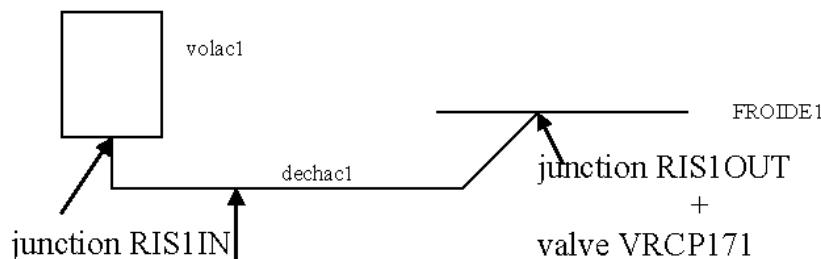


Figure 133.0.2: PERMIT : Example 4: Two DEADZONE for accumulator

In this example, the accumulator 1 is also represented by a volume VOLAC1 and an axial element DECHAC1. These two elements belong to the primary circuit.

There is a control valve VRCP171 at the junction RIS1OUT between DECHAC1 and the cold leg FROIDE1. VRCP171 is closed (PU = 0.). In addition to the previous example, there is an other control valve RIS221 in the middle of DECHAC1. RIS221 is closed.

Two DEADZONE must be defined for the accumulator:

1. the first one contains the volume VOLAC1 and a part of DECHAC1 from the junction RIS1IN to the control valve RIS221
2. the second one contains the other part of DECHAC1.

**PERMIT**      CIRCPIM  
list of            the elements        ...

<b>DEADZONE</b>	ZACC11			
	VOLAC1	DECHAC1	RIS1IN	RIS221
<b>DEADZONE</b>	ZACC12			
	DECHAC1	VRCP171	RIS221	

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 421/851

;

A NOFLOW condition is imposed on each side of junction RISOUT:

```
NOFLOW      DECHAC1    RIS1OUT;
NOFLOW      FROIDE1   RIS1OUT;
```

The level is imposed in VOLAC1:

```
LEVEL        VOLAC1    4.17          ;
```

Data are given in VOLAC1 for the initialization of the first DEADZONE:

```
REALVO      VOLAC1    LIQUID
                           TL      50.0
                           TV      51.0
                           X1      0.D0
                           X2      0.D0
                           X3      0.D0
GAS
                           P       41.5D5
                           TL      50.0
                           TV      51.0
                           X1      0.9980789
                           X2      0.D0
                           X3      0.D0
```

;

Data are given in DECHAC1 for the initialization of the second DEADZONE:

```
IPDECH1 = SCALAR   DECHAC1  6.0        ;
REALAX     DECHAC1  IPDECH1
                           P       136.0D5
                           TL      50.0
                           HVSAT
                           ALFA    1.0D-5
                           X1      0.D0
                           X2      0.D0
                           X3      0.D0
                           VL      1.0D-10
                           VV      1.0D-10
```

;

### Example 5

The **RHR (RRA)** is a residual heat removal circuit. It can be modelled by **CATHARE** to calculate the shutdown states. The elements of the RHR belong to the primary circuit and are linked to the primary legs through junctions with valves. At nominal power, for instance, the valves are closed and the RHR is a deadzone.

```
PERMINIT  CIRCPRIM ...
DEADZONE  ZRHR1
              EL1A  EL6A
              EL2A  EL3A
              EL4A  EL5A
```

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 422/851

;

A NOFLOW condition is given at the incoming junction J1A of the **RHR (RRA)**:

**NOFLOW**      CHAUDE3      J1A      ;

And at the outgoing junction J11A :

**NOFLOW**      EL5A      J11A;

**NOFLOW**      FROIDE2      J11A;

It is necessary to impose the flow repartition in the **RHR (RRA)** junctions:

**IMPOSFLOW** EL1A

    J4A      0.1

    J5A      0.8

    J10A      0.1;

Data are given in EL1A for the initialization of the deadzone :

**REALAX**      EL1A      IPRRA1

    P      1.8D5

    TL      20.D0

    HVSAT

    ALFA      1.0D-5

    X1      1.0D-7

    X2      1.0D-7

    X3      1.0D-7

    VL      1.0D-8

    VV      1.0D-8

;

### Example 6

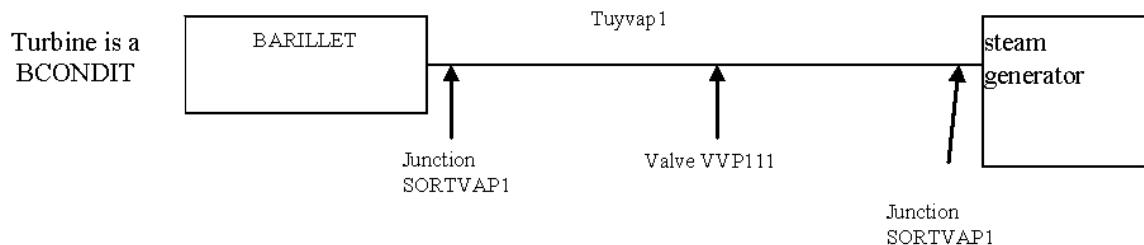


Figure 133.0.3: PERMIT : Example 6 for SG

For this initial state calculation we suppose that the steam lines are isolated so the control valves VVP11i are closed.

The deadzone contains the volume BARILLET and each steam line from the valve to the junction SORTVAPi between the steam line and the volume.

**PERMIT**      CIRCSEC      ...

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 423/851</a>

List of elements of the secondary circuit (TUYVAPi excepted)

<b>DEADZONE</b>	<b>ZONE1</b>	<b>BARILLET</b>
TUYVAP1	VVP111	SORTVAP1
TUYVAP2	VVP112	SORTVAP2
TUYVAP3	VVP113	SORTVAP3
TUYVAP4	VVP114	SORTVAP4
TURBINE		

;

Data are given in BARILLET for the initialization of the DEADZONE :

<b>REALVO</b>	<b>BARILLET</b>	<b>LIQUID</b>
	TL	167.70D0
	HVSAT	
	X1	1.0D-7
	X2	1.0D-7
	X3	1.0D-7
GAS		
	P	7.5D5
	TL	167.70D0
	HVSAT	
	X1	1.0D-7
	X2	1.0D-7
	X3	1.0D-7

;

**N.B** : the FORTRAN subroutine called in PILOT is PERMIN with the following arguments :

CALL PERMIN ( OBJNAM, CVAL, NVAL, \*9999 )

<b>OBJNAM</b>	: name of the circuit (character*8);
<b>CVAL</b>	: character*8 array containing data of the directive respecting the following order (list of elements, keyword DEADZONE, list of elements of the DEADZONE, name of junctions and control valves), i.e. in the example 5 [fondcuve, coeurmoy, bypass, volsup, ... , turbine, DEADZONE, zoneac1, volac1, dechac1, jrislin, vris221, DEADZONE, zoneac2, dechac1, vrcp171, vris221, DEADZONE, zonerra, el1a, el6a, el2a, el3a, el4a, el5a, el7a, el8a]
<b>NVAL</b>	length of array CVAL.

DE LA RECHERCHE À L'INDUSTRIE <b>cea</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 424/851

134

## PESEE DIRECTIVE

The **PESEE** directive is used to improve the performances of the OPEN MP parallelisation of the loop of hydraulic elements. If **PESEE** is activated, the cpu time needed by each element is calculated and stored. In a further **CATHARE** calculation, if the option PARALLEL PAQUET or PARALLEL ALL is used, it will be useful to balance the elements on the available processors.

It must be used in *command block* after RESTORE directive.

The **PESEE** directive can be used several times during a computation, but the measure must be stopped before starting again.

### Associated Keywords

OPTION, PERF, PRINSTRU

### Syntax

**PESEE**      **ON**                  or                  **OFF**                  ;

**ON**                  : starts the calculation of the cpu time used for each element.  
**OFF**                  : stops this calculation.

If **PERF** and **PESEE** directives are used together, the option **PESEE OFF** must be used before the option **PERF OFF**. (see example in OPTION directive).

**N.B** : the FORTRAN subroutine called in PILOT is PESEE: CALL PESEE (LALIDENH, OOW(1), OOW(2), \*9999)

LALIDENH  
 OOW(1)  
 OOW(2)

Pointeur on structure ALIDENH  
 CHARACTER\*8 : PESEE  
 CHARACTER\*8 value for PESEE :  
 ON or OFF

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 425/851

# 135

## PHYSCALE DIRECTIVE

Used on a **3-D** element after the **MESH**, **GEOM**, **CONNECT**, and **HYDR** directives, this **compulsory** directive of the *data block* enables the definition of the proper length scales to be used in the computation of the physical correlations, ‘scalar’ correlations dedicated to mass and energy transfer equations, ‘vector’ correlations dedicated to momentum equations.

**NB :** For all information about numbering, please refer to the user manual appendix “NUMBERING in THREED elements”

### Associated Keywords

**THREED**, **CONNECT**, **HYDR**, **GEOM**, **MESH**, **SINGULAR**

### Syntax

**PHYSCALE** elem

## 135.1 Hydraulic scale for mesh cell volume

<b>DHCELL</b> or  and/or or or	<b>LISTVOL</b> <b>DEFAULT</b>  <b>SEGMENT</b> <b>LISTPOIN</b>  <b>ZONE</b> <b>ZONE</b>	dh1 dh  begpt npt  zone_name ideb jdeb kdeb dh	dh2  endpt <b>VALUE</b> node1  dh node2  dh	...  <b>VALUE</b> dh node2  ...  nodenpt	dhn
---	---	--	--	--	-----

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 426/851

## 135.2 Hydraulic scale for mesh cell face

<b>DHEDGE</b>	<b>X</b>	<b>( or</b>	<b>TETA )</b>			
	<b>LISTFA</b>	<b>dh1</b>	<b>dh2</b>	<b>...</b>		<b>dhnx</b>
or	<b>DEFAULT</b>	<b>dh</b>				
and/or	<b>SEGMENT</b>	<b>begpt</b>	<b>endpt</b>	<b>VALUE</b>	<b>dh</b>	
or	<b>LISTPOIN</b>	<b>npt</b>	<b>node1</b>	<b>dh</b>		
or	<b>FXZONE</b>	<b>vx_zone_name</b>	<b>dh</b>	<b>node2</b>	<b>...</b>	<b>nodenpt</b>
or	<b>FXZONE</b>	<b>ideb</b>	<b>ifin</b>			
		<b>jdeb</b>	<b>jfin</b>			
		<b>kdeb</b>	<b>kfin</b>			
		<b>dh</b>				
<b>DHEDGE</b>	<b>Y</b>	<b>( or</b>	<b>R )</b>			
or	<b>LISTFA</b>	<b>dh1</b>	<b>dh2</b>	<b>...</b>		<b>dhnyc</b>
or	<b>DEFAULT</b>	<b>dh</b>				
and/or	<b>SEGMENT</b>	<b>begpt</b>	<b>endpt</b>	<b>VALUE</b>	<b>dh</b>	
or	<b>LISTPOIN</b>	<b>npt</b>	<b>node1</b>	<b>dh</b>		
or	<b>FYZONE</b>	<b>vy_zone_name</b>	<b>dh</b>	<b>node2</b>	<b>...</b>	<b>nodenpt</b>
or	<b>FYZONE</b>	<b>ideb</b>	<b>ifin</b>			
		<b>jdeb</b>	<b>jfin</b>			
		<b>kdeb</b>	<b>kfin</b>			
		<b>dh</b>				
<b>DHEDGE</b>	<b>Z</b>					
or	<b>LISTFA</b>	<b>dh1</b>	<b>dh2</b>	<b>...</b>		<b>dhnz</b>
or	<b>DEFAULT</b>	<b>dh</b>				
and/or	<b>SEGMENT</b>	<b>begpt</b>	<b>endpt</b>	<b>VALUE</b>	<b>dh</b>	
or	<b>LISTPOIN</b>	<b>npt</b>	<b>node1</b>	<b>dh</b>		
or	<b>FYZONE</b>	<b>vz_zone_name</b>	<b>dh</b>	<b>node2</b>	<b>...</b>	<b>nodenpt</b>
or	<b>FYZONE</b>	<b>ideb</b>	<b>ifin</b>			
		<b>jdeb</b>	<b>jfin</b>			
		<b>kdeb</b>	<b>kfin</b>			
		<b>dh</b>				
;						

**PHYSCALE elem** : operator to define the hydraulic scales introduced for node physical closure relationship on scalar nodes (DHCELL) and on vector nodes (DHEDGE ).

**DHCELL** : keyword introducing the hydraulic scale/mesh cell (m). It is followed by :

**LISTVOL** **dh1** : keyword followed by a list of n (referring to scalar mesh numbering) real numbers >0. equal to the hydraulic scale value in each mesh.

Or

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 427/851

<b>DEFAULT dh</b> <b>SEGMENT</b> <b>Begpt</b> <b>Endpt</b> <b>VALUE dh</b> <b>Or</b> <b>LISTPOIN</b> <b>npt</b> <b>VALUE dh</b> <b>textbfnode1</b> <b>... nodenpt</b> <b>Or</b> <b>ZONE</b> <b>szone</b> <b>or</b> <b>ibeg iend</b> <b>jdeb jend</b> <b>kdeb kend</b>  <b>dh</b>  <b>DHEDGE</b>  <b>X</b> <b>Y</b> <b>Z</b> <b>TETA</b> <b>R</b> <b>Z</b>	<p>: keyword followed by a real number &gt;0. equal to the hydraulic scale value. This value is taken by default for all the mesh cells. <i>If necessary, this can be followed by SEGMENT and/or LISTPOIN and/or ZONE (the optional part being repeated as many time as needed).</i></p> <p>: keyword to indicate that, for all the mesh cell numbers between begpt and endpt (referring to scalar mesh numbering), the hydraulic scale per mesh cell is taken equal to the VALUE dh.</p> <p>: first mesh number to be considered.</p> <p>: last mesh number to be considered. Then all the mesh numbers between begpt and endpt are taken into account.</p> <p>: keyword followed by a real number &gt;0. equal to the hydraulic scale.</p> <p>: keyword to indicate that, for a certain number of mesh cells, the hydraulic scale per mesh cell is taken equal to the VALUE dh.</p> <p>: Integer defining the number of scalar points taken into account.</p> <p>: keyword followed by a real number &gt;0. equal to the hydraulic scale.</p> <p>: scalar points (referring to scalar mesh numbering) taken into account.</p> <p>: Keyword indicating that all the scalar nodes of a rectangular zone have the same hydraulic diameter. This option may be repeated as many times as needed. It is followed by :</p> <p>: Name of a zone of scalar nodes previously defined in the MESH directive for the threed_name element</p> <p>: 6 integers for velocity plane numbers for node zone boundary definition.</p> <p>: Real &gt; 0. equal to the hydraulic diameter for the considered nodes.</p> <p>: keyword introducing the flow hydraulic scale/mesh cell (m), it has to be repeated for every direction.</p> <p><b>underbarNB</b> : This parameter is used in the physical model (interfacial friction, wall friction, etc.). Very high or very low values of this parameter should not be used to modify a specific physical model. Use rather a sensitivity multiplied parameter to modify a given physical model (See for example CCVs SP1CL and SP1CG in the WRITE directive)</p> <p><b>rectangular coordinate:</b>  <b>X</b>  <b>Y</b>  <b>Z</b></p> <p><b>Cylindrical coordinates :</b>  <b>TETA</b>  <b>R</b>  <b>Z</b></p>
---	---

	<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 428/851</a>

<b>LISTFA</b> <b>dh1 ... dhn</b>  or <b>DEFAULT dh</b>	<p>: keyword followed by a list of nx (or ny, or nz) real numbers &gt;0. (referring to the vector node numbering in the selected direction) equal to the flow hydraulic scale/mesh cell face for each of them.</p> <p>: keyword followed by a real number &gt;0. equal to the flow hydraulic scale/mesh cell face. This value is taken by default for all the mesh cell faces, in the considered direction.<i>If necessary, this can be followed by SEGMENT and/or LISTPOIN and/or FXZONE (or FYZONE or FZZONE) (the optional part being repeated as many time as needed).</i></p>
<b>SEGMENT</b>	<p>: keyword to indicate that, for all the mesh cell face numbers between begpt and endpt (referring to vector node numbering in the selected direction), the flow hydraulic scale/mesh cell face is taken equal to the VALUE dh.</p>
<b>Begpt</b> <b>Endpt</b>	<p>: number of the first mesh cell face to be considered.</p> <p>: number of the last mesh cell face to be considered. Then all the mesh cell face numbers between begpt and endpt are taken into account.</p>
<b>VALUE dh</b>  Or <b>LISTPOIN</b>  <b>npt</b>	<p>: keyword followed by a real number &gt;0. equal to the flow hydraulic scale/mesh cell face.</p> <p>: keyword to indicate that, for a certain number of mesh cells, the hydraulic scale per mesh cell is taken equal to the VALUE dh.</p> <p>: Integer defining the number of mesh cell faces taken into account.</p>
<b>VALUE dh</b>  <b>node1 ... nodenpt</b>  Or <b>FXZONE</b> <b>or FYZONE</b> <b>or FZZONE</b> <b>zone</b>  <b>ibeg iend</b> <b>jdeb jend</b> <b>kdeb kend</b>	<p>: keyword followed by a real number &gt;0. equal to the flow hydraulic scale/mesh cell face.</p> <p>: values of the mesh cell faces numbers (referring to vector node numbering in the selected direction) taken into account.</p> <p>: Keyword indicating that all the X vector (Y vector or Z vector) nodes of a rectangular zone have the same hydraulic diameter. This option may be repeated as many times as needed. It is followed by :</p> <p>: Name of a zone of X vector (Y vector or Z vector) nodes previously defined in the MESH directive for the elem element.</p> <p>: 6 integers for velocity plane numbers for node zone boundary definition.</p>
<b>dh</b>	<p>: Real &gt; 0. equal to the hydraulic diameter &gt;0. for the considered nodes.</p>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 429/851

136

## PICTG DIRECTIVE

The **PICTG** directive, used in the *command block*, activates both the calculation and the storage (in a separate file PICTG) of the maximum temperature and the maximum cumulated thickness of the internal and external oxide layer for each fuel rod and for three time intervals.

### Associated Keywords

FUELCHAR, CATAFUEL, REACTOR

### Syntax

**PICTG**      elem      T1      T2 ;

**elem** : name of a reactor or catafuel object.

**T1** : ending time of the first storage interval and beginning time of second storage interval.

**T2** : ending time of the second storage interval and beginning time of third storage interval.

**NB :**

1. the first storage interval begins with the calculation.
2. the third storage interval ends with the calculation.
3. The storage frequency refreshment of the PICTG file is based on the RESULT directive frequency for the reactor or catafuel element.

**Remark:**

1. This directive must be called after the GOFUEL directive,
2. The time intervals T1 and T2 can be change during the transient.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 430/851

<b>Example</b>
----------------

PICTG                    circtot                    20.D0                    40.D0                    ;

**NB :** The corresponding FORTRAN call is: CALL PICTG (OBJNAM, TTIME, \*9999)

OBJNAM	CHARACTER*8 reactor name or catafuel name
TTIME	Array of DOUBLE PRECISION containing T1 and T2

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 431/851

137

## PIQARE OPERATOR

The **PIQARE** operator is used to describe overflowing phenomena in a steam generator.

It creates in *data block* a group of two PIQREV submodules by defining their characteristics. These PIQREVs will be defined on two AXIAL elements. The **PIQARE** operator only defines and locates the PIQARE but does not connect the PIQARE (see ENABLE, DISABLE).

The user controls the PIQARE within the *command block* by using the **CATHARE** computation variables (CCV).

**NB :** The overflowing model can be activated / deactivated by using the directive **STAROVRF** (default) and **STOPOVRF**.

### Associated Keywords

**ENABLE**, **DISABLE**, **STAROVRF**, **STOPOVRF**, **VALBA** FOR A PIQxxx, **WRIBA** FOR A PIQxxx, **VALUE** FOR A PIQxxx, **WRITE** FOR A PIQxxx

### Syntax

```
pa =      PIQARE      AXIAL      elem1      iscal1
          ELEV        elev        SECT        Si
          ANGLE       angle       or          PERPENDI
          OVERFILL    AXIAL     elem2      iscal2
          RATINI      x           CONST      k           SECASP      sec
;
```

<b>pa</b>	: PIQARE name (max 7 Characters)
<b>elem1</b>	: main pipe name (AXIAL element in the steam generator receiving the main part of the feed water)
<b>iscal1</b>	: scalar point of elem1 on which the PIQARE is defined.
<b>ELEV</b> elev	: keyword followed by a real number $0 \leq \text{elev} \leq 1$ . defining the standardized position of the PIQARE injection point with respect to the bottom of the pipe (value used for stratification calculation (cf. ELEV in TEE operator definition). Put 0. if the mesh is vertical).
<b>SECT</b> Si	: keyword followed by a real number $> 0$ . defining the cross-section of the injection opening ( $\text{m}^2$ ).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 432/851

<b>ANGLE angle</b>	: keyword followed by a real number defining the angle between the direction of the injection and the mesh of the element (rad).
<b>PERPENDI</b>	: if the injection is perpendicular to the mesh of the element.
<b>OVERFILL</b>	: keyword to define the overflowing location.
<b>elem2</b>	: overflowing pipe name (AXIAL element in the steam generator receiving the overflowing feedwater).
<b>iscal2</b>	: scalar point of elem2 where the overflowing feedwater is located (secondary PIQREV element).
<b>RATINI x</b>	: keyword followed by a real number > 0. defining the initial overflowing rate to be used for 100% nominal power state.
<b>CONST k</b>	: keyword followed by a real number > 0. defining an adjusting coefficient.
<b>SECASP sec</b>	: keyword followed by a real number > 0. defining the cross-section in front of the injection ( $m^2$ ).

### Example

```

are1 =      PIQARE      AXIAL      downcom1      pdown1
            ELEV        0.0       SECT        1.D-2          PERPENDI
            OVERFILL    AXIAL      detour1     pret1
            RATINI     .08D0      CONST      1.02D0      SECASP      .2D0
            ;

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 433/851

# 138

## PIQBREK OPERATOR

The **PIQBREK** operator creates in *data block* a PIQBREK submodule by defining its characteristics. A PIQBREK will be defined on an AXIAL or VOLUME element. The PIQBREK operator only defines and locates the sink and **does not open the piqbrek** (see **OPENBREK**, **DISABLE**).

A PIQBREK corresponds to a removal of fluid or a leak in an element. It can be a reverse PIQBREK (in this case external injection conditions have to be defined). The user controls the PIQBREK within the executable block of the data set using the **CATHARE** computation variables (CCV). The flowrate is always calculated by **CATHARE**.

### Associated Keywords

**OPENBREK**, **DISABLE**, **VALBA** FOR A PIQxxx, **VALUE** FOR A PIQxxx, **WRIBA** FOR A PIQxxx, **WRITE** FOR A PIQxxx

### 138.1 PIQBREK on an 1-D element

#### Syntax

```
pb =      PIQBREK      AXIAL      elem
          SECT        z1           LENGTH     z2           (SINGULAR   z3)
          (PURGE       (z4 ))      or           (EVENT      (z4 ))    ;

```

<b>elem</b>	: Pipe name
<b>SECT</b> z1	: keyword followed by a real number >0 giving the maximum PIQBREK cross-section (m <sup>2</sup> ).
<b>LENGTH</b> z2	: keyword followed by a real number $\geq 0$ giving the length of the nozzle of the piqbrek (m).
<b>SINGULAR</b> z3	: OPTIONAL keyword followed by a real number $\geq 0$ defining the singular loss of pressure coefficient. Default value is 0.
<b>PURGE</b> z4	: OPTIONAL keyword indicating that the PIQBREK has to be seen like a DRAIN, followed by a real number $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if $\alpha < z4$ only liquid is extracted. Default value for z4 is 0.99 .

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 434/851

**EVENT z4** : OPTIONAL keyword indicating that the PIQBREK has to be seen like a VENT, followed by a real number  $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if  $\alpha > z4$  only gas is extracted. Default value for z4 is 0.01 .

#### Example

```
brech =      PIQBREK      AXIAL      coldleg
              SECT        0.01       LENGTH     0.005      SINGULAR    1.D-3 ;
```

## 138.2 PIQBREK on a 0-D element

#### Syntax

```
pb =      PIQBREK      VOLUME      elem
              SECT        z1          (SINGULAR  z2 )
              (PURGE      (z3 ) )      or           (EVENT      (z3 ) )
              ;
```

**elem** : Volume name  
**SECT z1** : keyword followed by a real number  $>0$ . giving the maximum PIQBREK cross-section ( $m^2$ ).  
**SINGULAR z2** : OPTIONAL keyword followed by a real number  $\geq 0$  defining the singular loss of pressure coefficient. Default value is 0.  
**PURGE z3** : OPTIONAL keyword indicating that the PIQBREK has to be seen like a DRAIN, followed by a real number  $0 \leq z3 \leq 1$ . z3 is the void fraction threshold value: if  $\alpha < z3$  only liquid is extracted. Default value for z3 is 0.99 .  
**EVENT z3** : OPTIONAL keyword indicating that the PIQBREK has to be seen like an VENT, followed by a real number  $0 \leq z3 \leq 1$ . z3 is the void fraction threshold value: if  $\alpha > z3$  only gas is extracted. Default value for z3 is 0.01 .

#### Example

```
brech =      PIQBREK      VOLUME      PRESSU
              SECT        0.01       SINGULAR    1.D-3      ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 435/851

139

## PIQREV OPERATOR

The **PIQREV** operator creates in *data block* a PIQREV submodule by defining its characteristics. Any required number of PIQREVs can be defined in **CATHARE**, but 200 is the maximum supported by the reader. A PIQREV will be defined on an AXIAL, THREED or VOLUME element. The PIQREV operator only defines and locates the PIQREV and **does not connect the piqrev** (see **ENABLE**, **DISABLE**).

A **PIQREV** represents a branch which can be set on a mesh of an axial, threed or on a volume element. It can be seen like an external SINK or a external SOURCE.

The user controls the PIQREV within the executable block of the data set by using the **CATHARE** computation variables (CCV). The flowrate is given to **CATHARE** by CCV ( $Q > 0$ : the flowrate comes from the outside, the PIQREV is an external SOURCE;  $Q < 0$ : the flowrate is taken from the element, the PIQREV is an external SINK).

### Associated Keywords

**ENABLE**, **DISABLE**, **VALBA** FOR A PIQxxx, **VALUE** FOR A PIQxxx, **WRIBA** FOR A PIQxxx, **WRITE** FOR A PIQxxx

## 139.1 PIQREV on an 1-D element

### Syntax

pb =	<b>PIQREV</b>	<b>AXIAL</b>	<b>elem</b>	<b>EXTERNAL</b>	<b>ip</b>	
	<b>ELEV</b>	<b>z1</b>	<b>SECT</b>	<b>z2</b>	<b>ANGLE</b>	<b>z3</b>
		or	<b>PERPENDI</b>			
	<b>(PURGE</b>	<b>(z4)</b>		<b>EVENT</b>	<b>(z4))</b>	
	<b>(PFM</b>	or	<b>VFM</b>	;		

<b>elem</b>	: pipe name
<b>ip</b>	: scalar point of the meshing of the element.
<b>ELEV z1</b>	: keyword followed by a real number $0 \leq z1 \leq 1$ defining the standardized position of the PIQREV injection point with respect to the bottom of the pipe.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 436/851

<b>SECT</b> z2	: keyword followed by a real number $> 0$ . defining the cross-section of the injection opening ( $\text{m}^2$ ).
<b>ANGLE</b> z3	: keyword followed by a real number defining the angle between the direction of the injection and the meshing of the element (rad).
<b>PERPENDI</b>	: if the injection is perpendicular to the mesh of the element.
<b>PURGE</b> z4	: OPTIONAL keyword indicating that the PIQREV has to be seen like a PURGE, followed by a real number $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if $\alpha < z4$ only liquid is extracted. Default value for z4 is 0.99 .
<b>EVENT</b> z4	: OPTIONAL keyword indicating that the PIQREV has to be seen like an EVENT followed by a real number $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if $\alpha > z4$ only gas is extracted. Default value for z4 is 0.01 .
<b>PFM</b> or <b>VFM</b>	: OPTIONAL keywords to indicate a specific behavior in case of injection (source behavior) - <b>VFM</b> : mixture before separation - <b>PFM</b> : separation before mixture <b>NB</b> : CCV used to impose injection conditions are specific to these options and different from standard PIQREV ones.

### Example

In the data bloc :

```
ipin =      SCALAR    froide3    EXTERNAL   18          ;  
rcvin =     PIQREV    AXIAL      froide3    ipin        ELEV       1.D0  
                      SECT       5.9D-3    PERPENDI  ;
```

In the executable bloc :

```
qchar =      3.8D0      ;  
tchar =      292.D0     ;  
WRITE       qchar      TOTFLOW    rvcin ;  
WRITE       tchar      TLIQEXT    rvcin ;  
WRITE       tchar      TGASEXT   rvcin ;  
WRITE       1.D-5      ALFAEXT   rvcin ;  
ENABLE      rvcin ;
```

In the data bloc :

```
ipout =     SCALAR    froide4    5.4 ;  
rcvout =    PIQREV    AXIAL      froide4  
              EXTERNAL  ipout      0.D0      SECT       3.49D-3    PERPENDI ;  
ELEV
```

In the executable bloc :

```
qdech =      -5.D0 ;  
here qdech is negative, so the PIQREV is seen as a SINK. No more information are required  
WRITE       qdech      TOTFLOW    rcvout ;  
ENABLE      rcvout ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 437/851

## 139.2 PIQREV on a 0-D element

### Syntax

pb =	<b>PIQREV</b>	<b>VOLUME</b>	elem	<b>EXTERNAL</b>		
	<b>ELEV</b>	z1	<b>SECT</b>	z2	<b>LENGTH</b>	z3
	<b>(PURGE</b>	(z4)	or	<b>EVENT</b>	(z4))	
	<b>(PFM</b>	or	<b>VFM</b> )	;		

<b>elem</b>	: Volume name
<b>ELEV</b> z1	: keyword followed by a real number $\geq 0$ giving the elevation of the PIQREV from the bottom of the volume (m).
<b>SECT</b> z2	: keyword followed by a real number $> 0$ defining the cross-section of the injection opening ( $m^2$ ).
<b>LENGTH</b> z3	: keyword followed by a real number $> 0$ defining the piqrev penetration length in the volume (m).
<b>PURGE</b> z4	: OPTIONAL keyword indicating that the PIQREV has to be seen like a DRAIN, followed by a real number $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if $\alpha < z4$ only liquid is extracted. Default value for z4 is 0.99.
<b>EVENT</b> z4	: OPTIONAL keyword indicating that the PIQREV has to be seen like an VENT followed by a real number $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if $\alpha > z4$ only gas is extracted. Default value for z4 is 0.01.
<b>PFM</b> or <b>VFM</b>	: OPTIONAL keywords to indicate a specific behavior in case of injection (source behavior) - <b>VFM</b> : mixture before separation - <b>PFM</b> : separation before mixture <b>NB</b> : CCV used to impose injection conditions are specific to these options and different from standard PIQREV ones.

### Example

RENPR =	<b>PIQREV</b>	<b>VOLUME</b>	pressu	<b>EXTERNAL</b>		
	<b>ELEV</b>	1.71	<b>SECT</b>	7.D-5	<b>LENGTH</b>	0.D0
						;

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 438/851</a>

### 139.3 PIQREV on a 3-D element

#### Syntax

```
pb =      PIQREV      THREED      Elem      EXTERNAL    ip
          SECT         z1          ANGLEZ     z2          ANGLEX      z3
          (PURGE)     (z4)        or          EVENT       (z4)) ;
```

**elem** : threed name  
**ip** : scalar point of the meshing of the element.  
**SECT z1** : keyword followed by a real number  $> 0$ . defining the cross-section of the injection opening ( $\text{m}^2$ ).  
**ANGLEZ z2** : keyword followed by a real number defining the angle between the direction of the injection and the meshing along Z axis of the element (rad).  
**ANGLEX z3** : keyword followed by a real number defining the angle between the direction of the injection and the meshing along X axis of the element (rad).  
**PURGE z4** : OPTIONAL keyword indicating that the PIQREV has to be seen like a DRAIN, followed by a real number  $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if  $\alpha < z4$  only liquid is extracted. Default value for z4 is 0.99 .  
**EVENT z4** : OPTIONAL keyword indicating that the PIQREV has to be seen like an VENT followed by a real number  $0 \leq z4 \leq 1$ . z4 is the void fraction threshold value: if  $\alpha > z4$  only gas is extracted. Default value for z4 is 0.01 .

#### Example

In the data bloc :

```
ipin =      LOCATE3D      Cuve3d      3 4 5 ;  
  
rcvin =      PIQREV      THREED      Cuve3D      EXTERNAL    ipin
              SECT         5.9D-3    ANGLEZ     0.D0        ANGLEX      0.D0 ;
```

In the executable bloc :

```
qchar =      3.8D0      ;  
tchar =      292.D0      ;  
WRITE      qchar      TOTFLOW      rcvin ;  
WRITE      tchar      TLIQEXT      rcvin ;  
WRITE      tchar      TGASEXT      rcvin ;  
WRITE      1.D-5      ALFAEXT      rcvin ;  
ENABLE      rcvin ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 439/851

140

## PIQSEB OPERATOR

The **PIQSEB** operator creates in *data block* a PIQSEB submodule by defining its characteristics. Any required number of PIQSEBs can be defined in **CATHARE**, but 200 is the maximum supported by the reader. A PIQSEB will be defined on an AXIAL or VOLUME element. The PIQSEB operator only defines and locates the PIQSEB and **does not connect the PIQSEB** (see **ENABLE**, **DISABLE**).

A **PIQSEB** represents a branch terminated by a safety valve. This branch can be set on a mesh of an axial element or on a volume.

The user controls the PIQSEB within the executable block of the data set by using the **CATHARE** computation variables (CCV). The flowrate through the branch and the opening of the PIQSEB are calculated by **CATHARE** ( $Q>0$  : flowrate coming from the outside and  $Q<0$ : outgoing flowrate).

### Associated Keywords

**ENABLE**, **DISABLE**, **VALBA** FOR A PIQxxx, **VALUE** FOR A PIQxxx, **WRIBA** FOR A PIQxxx, **WRITE** FOR A PIQxxx

### Syntax

<b>pb =</b> <b>or</b>	<b>PIQSEB</b> <b>VOLUME</b> <b>SECT</b> <b>(SINGULAR</b> 	<b>AXIAL</b> <b>elem</b> <b>z2</b> <b>z4)</b>	<b>elem</b> <b>ELEV</b> <b>(DELTAH</b> 	<b>ip</b> <b>z1</b> <b>z3)</b>	
	<b>SAFETY</b> <b>COURSE</b> <b>RAID1</b> <b>TCVFUITE</b> <b>(DTDERIV</b> <b>PREOP1</b> <b>DELTAP1</b> <b>DELHYS1</b> <b>SECMIN1</b> <b>SECMAX1</b> <b>PREOP2</b> <b>DELTAP2</b> <b>DELHYS2</b> <b>SECMIN2</b> <b>SECMAX2</b>	<b>safname</b> <b>z7</b> <b>z9</b> <b>z11</b> <b>z13)</b> <b>z14</b> <b>z15</b> <b>z16</b> <b>z17</b> <b>z18</b> <b>z19</b> <b>z20</b> <b>z21</b> <b>z22</b> <b>z23</b>	<b>VOLMIN</b> <b>X0</b> <b>RAID2</b> <b>TCVENCR</b>	<b>z5</b> <b>z8</b> <b>z10</b> <b>z12</b>	<b>VOLMAX</b> <b>z6</b>

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 440/851

<b>(ISOLATED</b>	isname	<b>PREOPEN</b>	z24	<b>PRECLOSE</b>	z25
<b>PREREST</b>	z26				
<b>TCVFUITE</b>	z27	<b>TCVENCER</b>	z28		
<b>(DTDERIV</b>	z29 )				
<b>(PURGE</b>	(z30)		<b>EVENT</b>	(z30))	
<b>(NOREVERS</b>	;				

#### *GLOBAL DATA*

**AXIAL** elem : keyword followed by the pipe name.  
**ip** : if AXIAL element, scalar point of the meshing of the element.  
**VOLUME** elem : keyword followed by the volume name.  
**ELEV** z1 : if VOLUME element, keyword followed by a real number  $0 \leq z1$  defining the elevation of the PIQSEB injection point with respect to the bottom of the volume (m).  
**SECT** z2 : keyword followed by a real number  $> 0$ . defining the cross-section of the maximum opening of the PIQSEB ( $m^2$ ).  
**DELTAH** z3 : OPTIONAL keyword followed by a real number  $\geq 0$ . defining the elevation of the PIQSEB above its connection point (m).  
**SINGULAR** z4 : OPTIONAL keyword followed by a real number  $\geq 0$ . defining the singular loss of pressure coefficient.

#### *SAFETY SEBIM DATA*

**SAFETY** namsafe : keyword followed by the name of the safety valve SEBIM.  
**VOLMIN** z5 : keyword followed by a real number  $> 0$ . defining the minimum volume of the head ( $m^3$ ).  
**VOLMAX** z6 : keyword followed by a real number  $> 0$ . defining the maximum volume of the head ( $m^3$ ).  
**COURSE** z7 : keyword followed by a real number  $> 0$ . defining the coil spring run (m).  
**X0** z8 : keyword followed by a real number  $> 0$ . defining the initial force (N).  
**RAID1** z9 : keyword followed by a real number  $> 0$ . defining the stiffness of the first coil spring (N/m).  
**RAID2** z10 : keyword followed by a real number  $> 0$ . defining the stiffness of the second coil spring (N/m).  
**TCVFUITE** z11 : keyword followed by a real number  $0 \leq z11 \leq 1$  defining the maximum normalized leak cross-section. This value is used in case of failure of type "leak" of the valve (IFailure =6 or 12 ). Then the smallest opening of the valve will be PU = z11 \* XFailure. (The failures are imposed by CCVs).  
**TCVENCER** z12 : keyword followed by a real number  $0 \leq z12 \leq 1$ . defining the maximum fouling. This value is used in case of failure of type "fouling" of the valve (IFailure = 7 or 11). Then the biggest opening of the valve will be PU = z12 \* XFailure.  
**(DTDERIV** z13) : OPTIONAL keyword giving the delay to reach the maximum derivative of the calibration pressure (case of fault IFailure = 9).

#### *FIRST STOPCOCK DATA*

**PREOP1** z14 : keyword followed by a real number  $> 0$ . defining the opening pressure of the first stopcock (the "closing pressure" of the safety SEBIM) (Pa).  
**DELTAPI1** z15 : keyword followed by a real number  $> 0$ . defining the  $\Delta_{PRI}$  of the first stopcock (Pa).  
**DELHYS1** z16 : keyword followed by a real number  $> 0$ . defining the hysteresis  $\Delta_{PRH1}$  of the first stopcock (Pa) (usually  $\Delta_{PRH1} = \Delta_{PRI}$  ).

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 441/851</a>

- SECMIN1** z17 : keyword followed by a real number > 0. defining the minimum cross-section of the first coil spring ( $m^2$ ) (when it is closed, usually secmin1 = 0.).
- SECMAX1** z18 : keyword followed by a real number > 0. defining the maximum cross-section of the first coil spring ( $m^2$ ) (when it is open).

#### *SECOND STOPCOCK DATA*

- PREOP2** z19 : keyword followed by a real number > 0. defining the opening pressure of the second stopcock (the “opening pressure” of the safety SEBIM) (Pa).
- DELTAP2** z20 : keyword followed by a real number > 0. defining the  $\Delta_{PR2}$  of the second stopcock (Pa).
- DELHYS2** z21 : keyword followed by a real number > 0. defining the hysteresis  $\Delta_{PRH2}$  of the second stopcock (Pa) (usually  $\Delta_{PRH2} = \Delta_{PR2}$  ).
- SECMIN2** z22 : keyword followed by a real number > 0. defining the minimum cross-section of the second coil spring ( $m^2$ ) (when it is closed, usually secmin2 = 0.).
- SECMAX2** z23 : keyword followed by a real number > 0. defining the maximum cross-section of the second coil spring ( $m^2$ ) (when it is open).

#### *ISOLATED SEBIM DATA (Optional)*

- ISOLATED** isnam : keyword followed by the name of the isolated SEBIM.
- PREOPEN** z24 : keyword followed by a real number > 0. defining the opening pressure of the safety valve (Pa).
- PRECLOSE** z25 : keyword followed by a real number > 0. defining the closing pressure of the safety valve (Pa).
- PREREST** z26 : keyword followed by a real number > 0. defining the rest pressure of the safety valve (Pa). Beyond this pressure, the safety valve is open.
- TCVFUITE** z27 : keyword followed by a real number  $0. \leq z27 \leq 1$ . defining the maximum normalized leak cross-section. This value is used in case of failure of type “leak” of the valve (IFailure =6 or 12 ). Then the smallest opening of the valve will be PU = z27 \* XFailure. (The failures are imposed by CCVs).
- TCVENC** z28 : keyword followed by a real number  $0. \leq z28 \leq 1$ . defining the maximum fouling. This value is used in case of failure of type “fouling” of the valve (IFailure = 7 or 11). Then the biggest opening of the valve will be PU = z28 \* XFailure.
- (DTDERIV** z29) : OPTIONAL keyword giving the delay to reach the maximum derivative of the calibration pressure (case IFailure = 9).

#### *OTHER DATA*

- PURGE** z30 : OPTIONAL keyword indicating that the PIQSEB has to be seen like a DRAIN, followed by a real number  $0. \leq z30 \leq 1$ . z30 is the void fraction threshold value: if  $\alpha > z30$  only gas is extracted. Default value for z30 is 0.99 .
- EVENT** z30 : OPTIONAL keyword indicating that the PIQSEB has to be seen like an VENT followed by a real number  $0. \leq z30 \leq 1$ . z30 is the void fraction threshold value: if  $\alpha > z30$  only gas is extracted. Default value for z30 is 0.01 .
- NOREVERS** : OPTIONAL keyword. If this keyword is present, then no reverse flow is allowed. In that case, external flowrate is set to zero, and external values of fluid properties are not required.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 442/851

<b>Example</b>
----------------

In the data bloc :

PIQSEB1 =	PIQSEB	VOLUME	pressu	
		ELEV	12.77	
		SECT	2.D-3	
		DELTAH	0.	
		SINGULAR	0.	
		SAFETY	SEBIM1	
			VOLMIN	2.D-3
			VOLMAX	2.1D-3
			COURSE	17.D-3
			X0	5.677D-3
			RAID1	0.65D8
			RAID2	0.4D8
			TCVFUITE	0.1
			TCVENCR	0.05
			PREOP1	164.D5
			DELTAP1	2.D5
			DELHYS1	2.D5
			SECMIN1	0.
			SECMAX1	0.98D-3
			PREOP2	170.D5
			DELTAP2	2.D5
			DELHYS2	4.D5
			SECMIN2	0.
			SECMAX2	0.98D-3
		ISOLATED	SEBIM2	
			PREOPEN	146.D5
			PRECLOSE	139.D5
			PREREST	16.D5
			TCVFUITE	0.1
			TCVENCR	0.05 ;

In the executable bloc :

PRESS =	1.D5 ;	PEXT	PIQSEB1;
WRITE	PRESS		
ENABLE	PIQSEB1 ;		

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 443/851

141

## PIQSOUP OPERATOR

The **PIQSOUP** operator creates in *data block* a PIQSOUP submodule by defining its characteristics. Any required number of PIQSOUPs can be defined in **CATHARE**, but 200 is the maximum supported by the reader. A PIQSOUP will be defined on an AXIAL or VOLUME element. The PIQSOUP operator only defines and locates the PIQSOUP and **does not connect the PIQSOUP** (see **ENABLE**, **DISABLE**).

A **PIQSOUP** represents a branch terminated by a safety valve. This branch can be set on a mesh of an axial element or on a volume.

The user controls the PIQSOUP within the executable block of the data set by using the **CATHARE** computation variables (CCV). The position of the safety valve is calculated by **CATHARE**. The flowrate through the branch is calculated by **CATHARE** ( $Q>0$  : flowrate coming from the outside and  $Q<0$  : outgoing flowrate).

### Associated Keywords

**ENABLE**, **DISABLE**, **VALBA** FOR A PIQxxx, **VALUE** FOR A PIQxxx, **WRIBA** FOR A PIQxxx, **WRITE** FOR A PIQxxx

### Syntax

PB =	<b>PIQSOUP</b>	<b>AXIAL</b>	<b>elem</b>	<b>ip</b>	
<b>or</b>	<b>VOLUME</b>	<b>elem</b>	<b>ELEV</b>	<b>z1</b>	
	<b>SECT</b>	<b>z2</b>	<b>(DELTAH</b>	<b>z3)</b>	<b>(SINGULAR</b> <b>z4)</b>
	<b>PRESSURE</b>	<b>z5</b>	<b>DELTAPE</b>	<b>z6</b>	
	<b>TCVFUIITE</b>	<b>z7</b>			
	<b>TCVENCR</b>	<b>z8</b>			
	<b>(DTDERIV</b>	<b>z9)</b>			
	<b>(PURGE</b>	<b>(z10)</b>			
<b>or</b>	<b>EVENT</b>	<b>(z10))</b>			
	<b>(NOREVERS)</b>	<b>;</b>			

**AXIAL elem ip** : keyword followed by the pipe name and the scalar point of the meshing of the element.  
**VOLUME elem** : keyword followed by the volume name.  
**ELEV z1** : if VOLUME element, keyword followed by a real number  $0 \leq z1$  defining the elevation of the PIQSOUP injection point with respect to the bottom of the volume (m).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 444/851

<b>SECT z2</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the maximum opening of the PIQSOUP ( $\text{m}^2$ ).
<b>DELTAH z3</b>	: OPTIONAL keyword followed by a real number $\geq 0$ . defining the elevation of the PIQSOUP upon its connection point (m).
<b>SINGULAR z4</b>	: OPTIONAL keyword followed by a real number $\geq 0$ . defining the singular loss of pressure coefficient.
<b>PRESSURE z5</b>	: keyword followed by a real number $> 0$ . defining the calibration pressure of the PIQSOUP (Pa).
<b>DELTAP z6</b>	: keyword followed by a real number $> 0$ . defining the pressure difference with respect to the maximum opening of the PIQSOUP (Pa).
<b>TCVFUITE z7</b>	: keyword followed by a real number $0 \leq z7 \leq 1$ . defining the maximum normalized leak cross-section. This value is used in case of failure of type "LEAK" of the valve (IFailure = 6 or 12). Then the smallest opening of the valve will be PU = z7 * XFailure. (The failures are imposed by CCVs).
<b>TCVENCER z8</b>	: keyword followed by a real number $0 \leq z8 \leq 1$ . defining the maximum fouling. This value is used in case of failure of type "FOULING" of the valve (IFailure = 7 or 11). Then the biggest opening of the valve will be PU = z8 * XFailure.
<b>(DTDERIV z9)</b>	: OPTIONAL keyword giving the delay to reach the maximum derivative of the calibration pressure (case of fault IFailure = 9).
<b>(PURGE z10)</b>	: OPTIONAL keyword indicating that the PIQSOUP has to be seen like a DRAIN, followed by a real number $0 \leq z10 \leq 1$ . z10 is the void fraction threshold value: if $\alpha < z10$ only liquid is extracted. Default value for z10 is 0.99 .
<b>(EVENT z10)</b>	: OPTIONAL keyword indicating that the PIQSOUP has to be seen like a VENT followed by a real number $0 \leq z10 \leq 1$ . z10 is the void fraction threshold value: if $\alpha > z10$ only gas is extracted. Default value for z10 is 0.01 .
<b>NOREVERS</b>	: OPTIONAL keyword. If this keyword is present, then no reverse flow is allowed. In that case, external flowrate is set to zero, and external values of fluid properties are not required.

### Example

In the data bloc :

```

SUR01 =    PIQSOUP      AXIAL
          TUYVAPI1    12
          SINGULAR     0.
          DELTAP       1.D5
          TCVENCER    0.1
          DTDERIV      0.           NOREVERS ;

```

In the executable bloc :

```

PRESS =      1.D5 ;
WRITE      PRESS      PEXT      SUR01;
ENABLE      SUR01;

```

NOREVERS has been specified

No more informations are required in case of internal pressure becoming lower than PRESS  
Otherwise one should specify ALFAEXT, X1EXT, TLIQEXT, TGASEXT, LIQFRX1, GASFRX1, ...

142

# PIQVANNE OPERATOR

The **PIQVANNE** operator creates in *data block* a PIQVANNE submodule by defining its characteristics. Any required number of PIQVANNEs can be defined in **CATHARE**, but 200 is the maximum supported by the reader. A PIQVANNE will be defined on an AXIAL or VOLUME element. The PIQVANNE operator only defines and locates the PIQVANNE and **does not connect it** (see **ENABLE**, **DISABLE**).

A PIQVANNE represents a branch terminated by one or two valves (or one or two valves and a check valve). This branch can be set on a mesh of an axial element or on a volume.

The user controls the PIQVANNE within the executable block of the data set using the **CATHARE** computation variables (CCV). The position of the valve(s) is given to **CATHARE**. The position of the check valve is calculated by **CATHARE**. The flowrate through the branch is calculated by **CATHARE** ( $Q>0$  : flowrate coming from the outside and  $Q<0$ : out-going flowrate).

### **Associated Keywords**

ENABLE, DISABLE, VALBA FOR A PIQxxx, VALUE FOR A PIQxxx, WRIBA FOR A PIQxxx, WRITE FOR A PIOxxx

---

## Syntax

PB = or	<b>PIQVANNE</b>	<b>AXIAL</b>	elem	ip		
	<b>VOLUME</b>	elem	<b>ELEV</b>	z1		
	<b>SECT</b>	z2	<b>(DELTAH</b>	z3)	<b>(SINGULAR</b>	z4)
	<b>ROREF</b>	z5				
<b>VALVE</b> or	valv1	<b>CV</b>	law1			
	<b>KM</b>	law1				
	<b>TCVFUITE</b>	z6	<b>TCVENCR</b>	z7		
<b>VALVE</b> or	valv2	<b>CV</b>	law2			
	<b>KM</b>	law2				
	<b>TCVFUITE</b>	z8	<b>TCVENCR</b>	z9		
<b>CHECK</b>	<b>VALVE</b>	clap	<b>CVMAX</b>	z10	<b>DELTAP</b>	z11
	<b>TCVFUITE</b>	z12	<b>TCVENCR</b>	z13		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 446/851

**(PURGE** (z14)      or **EVENT** (z14))  
**(NOREVERS)** ;

#### *GLOBAL DATA*

**AXIAL** elem : keyword followed by the pipe name.  
**ip** : if AXIAL element, scalar point of the meshing of the element. .  
**VOLUME** elem : keyword followed by the volume name.  
**ELEV** z1 : if VOLUME element, keyword followed by a real number  $0 \leq z1$  defining the elevation of the piqvanne injection point with respect to the bottom of the volume (m).  
**SECT** z2 : keyword followed by a real number  $> 0$ . defining the cross-section of the maximum opening of the piqvanne ( $m^2$ ).  
**DELTAH** z3 : OPTIONAL keyword followed by a real number  $\geq 0$  defining the elevation of the piqvanne upon its connection point (m).  
**SINGULAR** z4 : OPTIONAL keyword followed by a real number  $\geq 0$  defining the singular loss of pressure coefficient.  
**ROREF** z5 : Reference density for definition of capacities:  
- If  $z5 \leq 500 \text{ kg/m}^3$ , the capacity is supposed to be defined in critical steam flow condition  
- If  $z5 > 500 \text{ kg/m}^3$ , the capacity is supposed to be defined in sub-critical liquid flow condition

#### *FIRST VALVE DATA*

**VALVE** valv11 : keyword followed by the name of the first valve.  
**CV** law1 : keyword followed by the name of the law giving the capacity of the valve versus its position.  
**or**  
**KM** law1 : keyword followed by the name of the law giving the singular load loss of the valve versus its position for an application of type **COMETE**.  
**TCVFUITE** z6 : keyword followed by a real number  $0 \leq z6 \leq 1$ . defining the maximum leak cross-section. This value is used in case of failure of type "leak" of the valve (IFailure = 6 or 12). Then the smallest opening of the valve will be PU = z6 \* XFailure. (The failures are imposed by CCVs).

**Remark :** TCVFUIITE keyword is not allowed for an application of type **COMETE**

**TCVENCER** z7 : keyword followed by a real number  $0 \leq z7 \leq 1$ . defining the maximum fouling. This value is used in case of failure of type "fouling" of the valve (IFailure = 7 or 11). Then the biggest opening of the valve will be PU = z7 \* XFailure.

**Remark :** TCVENCER keyword is not allowed for an application of type **COMETE**

#### *SECOND VALVE DATA (optional)*

**VALVE** valv2 : keyword followed by the name of the second valve.  
**CV** law2 : keyword followed by the name of the law giving the capacity of the valve versus its position  
**or**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 447/851

**KM law2** : keyword followed by the name of the law giving the singular load loss of the valve versus its position for an application of type **COMETE**.

**TCVFUITE z8** : keyword followed by a real number  $0 \leq z8 \leq 1$  defining the maximum leak cross-section (see above)

*Remark* : TCVFUIITE keyword is not allowed for an application of type **COMETE**

**TCVENCR z9** : keyword followed by a real number  $0 \leq z9 \leq 1$  defining the maximum fouling (see above)

*Remark* : TCVENCR keyword is not allowed for an application of type **COMETE**

*CHECK VALVE DATA (optional)*

**CHECK VALVE** : keyword followed by the name of the check valve.  
clap

*Remark* : CHECK VALVE keyword is not allowed for an application of type **COMETE**

**CVMAX z10** : keyword followed by a real number  $0. \leq z10$  giving the maximum capacity of the check valve.

**DELTAP z11** : keyword followed by a real number  $0. \leq z11$  giving the opening pressure gradient of the check valve (Pa).

**TCVFUITE z12** : keyword followed by a real number  $0. \leq z12 \leq 1$ . defining the maximum initialization leak cross-section (see above).

**TCVENCR z13** : keyword followed by a real number  $0. \leq z13 \leq 1$ . defining the maximum fouling (see above).

#### *OTHER DATA*

**PURGE z14** : OPTIONAL keyword indicating that the piqvanne has to be seen like a DRAIN, followed by a real number  $0. \leq z14 \leq 1$ . z14 is the void fraction threshold value: if  $\alpha < z14$  only liquid is extracted. Default value for z14 is 0.99 .

**EVENT z14** : OPTIONAL keyword indicating that the piqsoup has to be seen like an VENT followed by a real number  $0. \leq z14 \leq 1$ . z14 is the void fraction threshold value: if  $\alpha > z14$  only gas is extracted. Default value for z14 is 0.01 .

**NOREVERS** : OPTIONAL keyword. If this keyword is present, then no reverse flow is allowed. In that case, external flowrate is set to zero, and external values of fluid properties are not required.

#### Example

In the data bloc :

law1 =	LAW	‘POSITION’	‘CV’
		0.D0	0.D0
		1.D0	3859.D0 ;
law2 =	LAW	‘POSITION’	‘CV’
		0.D0	0.D0

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 448/851

1.D0              550.D0 ;

ADG =	PIQVANNE	VOLUME	barillet
		ELEV	0.45
		SECT	1.02D-2
		DELTAH	0.
		SINGULAR	0.
		ROREF	980.
	VALVE	VALVE1	
		CV	law1
		TCVFUITE	0.1
		TCVENCR	0.05
	VALVE	VALVE2	
		CV	law2
		TCVFUITE	0.1
		TCVENCR	0.05
	CHECK	VALVE	CLAP
		CVMAX	1600.
		DELTAP	1.5E5
		TCVFUITE	0.1
		TCVENCR	0.05

NOREVERS ;

In the executable bloc :

PRESS =	5.D5 ;		
WRITE	PRESS	PEXT	ADG ;
ENABLE	ADG ;		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 449/851

143

## PNRSHAPE AND PNRSHAPX DIRECTIVES

These two directives are used to introduce a variable axial profile for the non residual (or neutronic) power for a wall generating power or a fuelwall.

The **PNRSHAPE** directive is used in the *data block*, after the **INTEGRATE** directive or after the wall assembly, to define a table of profiles.

The **PNRSHAPX** directive is used in the *command block*, before transient computation, in order to activate or deactivate the axial profile for the neutronic power.

### Associated Keywords

WALL, WALL3D, FUELCHAR, FUELPLAQ, PRESHAPX, PRESHAPE

### Syntax

<b>PNRSHAPE</b>	wall1	<b>SIGNAL</b>	p	...	R1n
signal_1	R11	R12	R13	...	R1n
signal_2	R21	R22	R23	...	R2n
...					
signal_p	Rp1	Rp2	Rp3	...	Rpn ;

<b>PNRSHAPX</b>	wall1	<b>SIGNAL</b>	s1 ;	
-----------------	-------	---------------	------	--

<b>wall1</b>	: name of the wall (or wall3d) or the fuelchar object for which the axial profile must be applied.
<b>SIGNAL</b>	: keyword followed for PNRSHAPE by a positive integer and representing the number of signal's values.
<b>p</b>	: integer > 0 representing the number of signal values.
<b>signal_i (i=1, ..., p)</b>	: list of the signal values. These are real numbers, which must be sorted from the lower to the higher value from i = 1 to p. If this condition is not respected, it provokes a fatal error message.
<b>Rij (i=1, ..., p), (j=1, ..., n)</b>	: list of the axial profile values for each value i of the signal and for each cell j of the wall or fuelchar. Real numbers > 0.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 450/851</a>	

**NB :** n = nwz is equal to the number of cells of the wall or fuelchar.

**s1** : real number chosen for the signal, which must be included in the range of values going from signal\_1 to signal\_p defined above.

**NB :** If this value is equal to one of the signals entered in the **PNRSHAPE** table, the profile used is the one corresponding to this signal. Else, the profile used is an interpolation between the two profiles corresponding to the signal values, which border s1.

- The value s1 = -999 is a particular value which deactivates the directive : come back to the initial axial profile defined by the operators creating the wall or the object FUELCHAR.

- If the value s1 is not included in the range of [signal\_1 ... signal\_p], it provokes a fatal error message.

### Example

In the data bloc :

PNRSHAPE	CARCB	SIGNAL	3	1.0	1.0
<b>1.0</b>	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0
<b>4.0</b>	0.098	0.195	0.29	0.38	0.471
0.556	0.634	0.707	0.773	0.831	0.882
0.924	0.957	0.981	0.995	1.0	
<b>6.0</b>	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0;	

In the executable bloc :

\* constant axial profile

PNRSHAPX	CARCB	SIGNAL	1. ;
----------	-------	--------	------

...

IF	( (TIME > TSIGNAL)	AND (ISIGNAL EQ 0 ));
----	--------------------	-----------------------

\* modifying the power axial profile of CARCB

PNRSHAPX	CARCB	SIGNAL	4. ;
	ISIGNAL	= 1	;

ENDIF ;

...

IF	( (TIME > TSIGNAL)	AND (ISIGNAL EQ 1 ));
----	--------------------	-----------------------

\* modifying again the power axial profile of CARCB

PNRSHAPX	CARCB	SIGNAL	5. ;
	ISIGNAL	= 2	;

ENDIF ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 451/851

In the data bloc :

PNRSHAPE	CARCB	SIGNAL	3		
<b>600.</b>	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	
<b>800.</b>	0.098	0.195	0.29	0.38	0.471
0.556	0.634	0.707	0.773	0.831	0.882
0.924	0.957	0.981	0.995	1.0	
<b>1000.</b>	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0;	

In the executable bloc :

\* modifying profile with respect to the **UO<sub>2</sub>** maximum temperature in CARCB

```
TCBMAX =   VALUE      UO2TEMP    CARCB      6 ;
PNRSHAPX  CARCB      SIGNAL     TCBMAX     ;
```

**NB** : The corresponding FORTRAN subroutine called in PILOT is PNRSHAPX. The arguments are the following ones :  
 CALL PNRSHAPX ( OBJNAM, RVAL, \*9999)

OBJNAM	CHARACTER*8 name of the wall or fuelchar where the axial profile for non residual power, is introduced
RVAL	DOUBLE PRECISION chosen value for the signal

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 452/851</a>

144

## POUNC DIRECTIVE

The **POUNC** directive is used to take into account the uncertainties related to torque and height for octants 1 and 2 in the case of the P100 pump (or P4) during a transient, in the *command block*. This directive consists in applying additional corrections to the standard **CATHARE** diphasic degradation model.

The homologous head and torque are calculated as follows :

$$\begin{aligned}
 H_{new} &= H_{calc} - MOY_h + X_{real} * SIGMA_h \\
 C_{new} &= C_{calc} - MOY_c + X_{real} * SIGMA_c \\
 MOY_h &\quad \text{is the mean value and } SIGMA_h \text{ the standard deviation for homologous head,} \\
 MOY_c &\quad \text{is the mean value and } SIGMA_c \text{ the standard deviation for homologous torque,} \\
 X_{real} &\quad \text{defines a real number that has to be given by the user for each octant.}
 \end{aligned}$$

**NB :** This directive can only be used for a P100 (or P4) pump type.

<b>Associated Keywords</b>
----------------------------

**PUMPCHAR**

<b>Syntax</b>
---------------

**POUNC**      **char**

<b>HAUT1</b>	hau1
<b>COUPL1</b>	coup1
<b>HAUT2</b>	hau2
<b>COUPL2</b>	coup2
	;

**char** : name of the pump for which uncertainties are taken into account.

**HAUT*i* hau*i* (i=1,2)** : value of multiplicative factor on the standard deviation of the height for octant “*i*”. It is followed by a real number, or by the keyword NONE if the uncertainty is not to be taken into account.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 453/851

**COUPLi      coup<sub>i</sub>** : value of multiplicative factor on the standard deviation of the torque for octant “i”.  
**(i=1,2)** It is followed by a real number, or by the keyword NONE if the uncertainty is not to be taken into account.

<b>Example</b>
----------------

POUNC	char1	HAUT1	0.0	
		COUPL1	NONE	
		HAUT2	1.65	
		COUPL2	-1.65	;

**NB1** : the FORTRAN subroutine called in PILOT is POUNC and the arguments are the following ones: CALL POUNC ( OBJNAM,OOF,OOI, \*9999 )

OBJNAM	CHARACTER*8 name of the fuelchar for the directive is to be activated
OOF	DOUBLE PRECISION (4): 4 values of the uncertainties for the pumpchar
OOI	INTEGER (4) : array of activation flags to indicated if the uncertainty is to be taken into account (1) or not (0)

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 454/851

145

## POWER DIRECTIVE

The **POWER** directive, in *command block*, enables the user to modify the power generated in a wall or in a fuel wall. It becomes effective when called and may be used several times during a computation. For fuel walls, this directive applies only when the user has defined the power (none CORE object defined or CORE object stopped using STOPNEUT directive).

### Associated Keywords

WALL, WALL3D, FUELCHAR

## 145.1 Modification of the power of a wall

### Syntax

<b>POWER</b>	wall1								
		<b>ABSOLUTE</b>		<b>REALIST</b>	<b>REALIST</b>	list1			
		or	<b>RELATIVE</b>	<b>REALIST</b>	<b>REALIST</b>	list2 ;			
		<b>POWER</b>							

<b>wall1</b>	: a wall name (WALL or WALL3D element) or list of wall names if several walls are to be modified with the same power values.
<b>ABSOLUTE</b>	: keyword specifying that the time origin is time 0. If the time origin is the time when the directive was used, then the keyword <b>RELATIVE</b> should be used.
<b>REALIST list1</b>	: list of time values (s).
<b>REALIST list2</b>	: list of power multiplying coefficients function of time. <b>The values are the same all along the wall.</b>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 455/851

### Example

```

POWER    wall1      ABSOLUTE   REALIST    0.        1.
          POWER       REALIST    100.      0.         ;
POWER    wall1      wall2      RELATIVE   REALIST    0.        1.
          POWER       REALIST    100.      0.5 ;

```

## 145.2 Modification of the power of a fuel structure

This directive is available only if none point kinetics model is used (**CORE**), or if it was used but it is stopped with **STOPNEUT** directive. This should apply to a **FUELCHAR** or a **FUELPLAQ** whose power definition is internal (given by laws). If the **FUELCHAR** power definition previously uses CCV (EXTERNAL power definition), the **FUELCHAR** power definition automatically becomes internal.

### Syntax

```

POWER    fuel1      POWER_type w1
          ABSOLUTE  or           RELATIVE
          REALIST   list1
          POWER_type REALIST   list2 ;

```

**fuel1** : a fuel element name or a list of fuel names if several are to be modified with the same power values.

**POWER\_type** : Keyword that may take the following values :

**POWNEUT**: neutronic (or non residual) power

**POWRES**: residual power

**w1** : real number >0. representing the power (W) to be multiplied by the coefficients given in list2.

**ABSOLUTE** : keyword specifying that the time origin is time 0. If the time origin is the time when the directive was used, then the keyword **RELATIVE** must be used.

**REALIST list1** : list of time values (s).

**REALIST list2** : list of power multiplying coefficients function of time

**The values are the same all along the fuel element.**

### Example

```

POWER    ccoeurm    POWNEUT    78.5292E3
          RELATIVE   REALIST    0.0       4.0       4.1       14.0
          POWNEUT   REALIST    1.0       1.0       0.1831   0.1717 ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 456/851

**N.B :** the FORTRAN subroutine called in PILOT is POWER : CALL POWER ( NTWALL, NCVAL, NRVAL, CVAL, RVAL, \*9999)

NTWALL	INTEGER, number of walls whose power law is modified.
NRVAL	INTEGER, number of values in the REALLIST
NCVAL	INTEGER, size of CVAL array = NTWALL +2 (wall) or NTWALL + 3 (fuelchar)
CVAL(NCVAL)	CHARACTER*8 array of the wall and variable names
RVAL(NRVAL*2+1)	First are the name of the walls, then 'POWNEUT ' or 'POWRES ' (case of a fuel wall), then 'ABSOLUTE' or 'RELATIVE' and finally 'POWNEUT ' or 'POWRES ' or 'POWER '. DOUBLE PRECISION array of : first the power value w1 (case of a fuel wall) and then the REALIST values (first time values) then power multiplying coefficient values

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 457/851

146

## PRESHAPE AND PRESHAPX DIRECTIVES

These two directives are used to introduce a variable axial profile for the residual power.

The **PRESHAPE** directive is used in the *data block*, after the **INTEGRATE** directive or after the fuelchar assembly, to define a table of profiles.

The **PRESHAPX** directive is used in the *command block*, before transient computation, in order to activate or deactivate the axial profile for the residual power.

<b>Associated Keywords</b>
----------------------------

**FUELCHAR, FUELPLAQ, PNRSHAPE, PNRSHAPX**

<b>Syntax</b>
---------------

<b>PRESHAPE</b>	<code>fuelchar1</code>	<b>SIGNAL</b>	<code>p</code>	
<code>signal_1</code>	<code>R11</code>	<code>R12</code>	<code>R13</code>	<code>...</code>
<code>signal_2</code>	<code>R21</code>	<code>R22</code>	<code>R23</code>	<code>...</code>
<code>signal_p</code>	<code>Rp1</code>	<code>Rp2</code>	<code>Rp3</code>	<code>...</code>
				<code>Rpn ;</code>

<b>PRESHAPX</b>	<code>fuelchar1</code>	<b>SIGNAL</b>	<code>s1 ;</code>
-----------------	------------------------	---------------	-------------------

<b>fuelchar1</b>	: name of the fuelchar for which the axial profile must be applied.
<b>SIGNAL</b>	: keyword followed for PRESHAPE by a positive integer and representing the number of signal values.
<b>p</b>	: integer > 0 representing the number of signal values.
<b>signal_i (i=1, ..., p)</b>	: list of the signal values. These are real numbers, which must be sorted from the lower to the higher value from i = 1 to p. If this condition is not respected, it provokes a fatal error message.
<b>Rij (i=1, ..., p), (j=1, ..., n)</b>	: list of the profile values for each value i of the signal and for each cell j of the fuelchar. Real numbers > 0. <b>NB</b> : n = nwz is equal to the number of cells of the fuelchar.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 458/851

**s1** : real number chosen for the signal, which must be included in the range of values going from signal\_1 to signal\_p defined above.

**NB** : If this value is equal to one of the signals entered in the **PRESHAPE** table, the profile used is the one corresponding to this signal. Else, the profile used is an interpolation between the two profiles corresponding to the signal values, which border s1

- The value s1 = -999 is a particular value which deactivates the directive : come back to the initial axial profile defined by the operator FUELCHAR.

- If the value s1 is not included in the range of [signal\_1 ... signal\_p], it provokes a fatal error message.

### Example

In the data bloc :

PRESHAPE	CARCB	SIGNAL	3		
<b>0.1</b>	0.01	0.09	0.1	0.15	0.21
0.28	0.35	0.39	0.45	0.52	0.59
0.68	0.71	0.85	0.92	1.0	
<b>0.3</b>	0.02	0.1	0.15	0.20	0.25
0.3	0.34	0.42	0.48	0.56	0.65
0.75	0.78	0.89	0.98	1.0	
<b>0.5</b>	0.05	0.15	0.17	0.25	0.3
0.36	0.47	0.58	0.6	0.65	0.7
0.78	0.85	0.91	0.96	1.0	;

In the executable bloc :

\*changing residual power profile for fuelchar CARCB

PRESHAPX    CARCB       SIGNAL      **0.4** ;

...

\*changing again residual power profile for fuelchar CARCB

PRESHAPX    CARCB       SIGNAL      **0.5** ;

**NB** : The corresponding FORTRAN subroutine called in PILOT is PRESHAPX. The arguments are the following ones :  
 CALL PRESHAPX ( OBJNAM, RVAL, \*9999 )

OBJNAM	CHARACTER*8 name of the fuelchar where the axial profile for residual power, is introduced
RVAL	DOUBLE PRECISION chosen value for the signal

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 459/851

147

## PRIN3D DIRECTIVE

The **PRIN3D** directive is used in *command block* only. It handles the management of the printing variables of a three-dimensional module. Using this directive, with the periodicity of the **PERIOD** directive for this threed element, the user may choose the printings variable and/or the choice of the default plane for printings.

### Associated Keywords

PERIOD, LIST, IMPRIME, MESSAGE, TITLE, SAVE, RESULT

### Syntax

```
PRIN3D keyword1      element value1      PLAN3D keyword2      plane value2      ... ;
```

<b>element</b>	: Name of the threed-type element
<b>PLAN3D</b>	: keyword followed by the reference plane for printings
<b>plane</b>	<ul style="list-style-type: none"> <li>- XZ to print in XZ plane. (this is the choice by default for RECTANG COORDINATES)</li> <li>- YZ to print in YZ plane. (this is the choice by default for CYLINDAR COORDINATES)</li> </ul>

<b>keywordi</b> <b>variable:</b>	<b>Default value of valuei:</b>
-------------------------------------	---------------------------------

<b>PRESSURE</b>	1
<b>LIQH</b>	1
<b>GASH</b>	1
<b>ALFA</b>	1
<b>LIQDENS</b>	1
<b>GASDENS</b>	1
<b>GASVXM</b>	1
<b>GASVYM</b>	1
<b>GASVZM</b>	1
<b>LIQVXM</b>	1

To  
be  
re-  
peated  
as  
many  
times  
as  
needed

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 460/851

LIQVYM	1	
LIQVZM	1	
TURBLIQ	0	
TURBGAS	0	
LIQTEMP	0	
GASTEMP	0	
SATTEMP	0	
SATTPV	0	
PV	0	
valuei	0/1 to disable/enable printing	

**NB1** : For each variable “keywordi” can be used alone.

#### Example

```
PRIN3D      TUBE      PLAN3D      YZ
              TURBGAS    0          TURBLIQ     1
              ;
```

**NB2** : the FORTRAN subroutine called in PILOT is PRIN3D : CALL PRIN3D (OOW(1), OOW(2), OOW(3), OOI(1), \*9999 )

The first time, this subroutine is called to specify the general following arguments related to the 3D element

OOW(1)	CHARACTER*8, name of the threed-type element
OOW(2)	CHARACTER*8, keyword “PLAN3D”
OOW(3)	CHARACTER*8, plane to print the variable(s), equal to “XZ” or “YZ”
OOI(1)	Integer, non used at the first called

The next time, this subroutine is called for each variable previously listed. In these cases, the arguments relate to the variable to be printed:

OOW(1)	CHARACTER*8, name of the threed-type element
OOW(2)	CHARACTER*8, name of the variable
OOW(3)	CHARACTER*8, not used initialized to “XXXXXXXX”
OOI(1)	Integer equal to 0/1 to disable/enable printing

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 461/851

# 148

## PRINSTRU DIRECTIVE

The **PRINSTRU** directive enables the user to initialize or modify the frequency of printouts of computation CPU times given by the directive **PERF**, in *command block* after **RESTORE** directive.

**Warning :** The **PRINSTRU** directive can not be used before **GOPERM** directive or **RESETIME** directive.

The **PRINSTRU** directive can be used several times during a computation associated with the directive **PERF**.

### Associated Keywords

**OPTION, PERF, PESEE**

### Syntax

```
PRINSTRU      SECOND      s
                  or
                  NSTEP       n ;
```

A choice then has to be made between the following :

<b>SECOND</b> s	: keyword followed by a real number > 0. Print at every s second interval (s).
<b>NSTEP</b> n	: keyword followed by an integer > 0 . Print at every n step interval.

### Example

```
PERF      ON ;
PRINSTRU SECOND    10. ;
(transient   block)
PERF      OFF ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 462/851

**N.B :** the FORTRAN subroutine called in PILOT is PRINSTRU: CALL PRINSTRU (LALIDENH, OOI(1), OOI(2), OOF(1), OOW(1), OOW(2), \*9999)

LALIDENH	Pointeur on structure ALIDENH.
OOI(1)	Type of frequency ( equal "1" if "NSTEP" keyword used ; equal "2" if "SECOND" keyword used).
OOI(2)	INTEGER value for NSTEP.
OOF(1)	DOUBLE PRECISION value for SECOND.
OOW(1)	CHARACTER*8 : PRINSTRU.
OOW(2)	CHARACTER*8 keyword of PRINSTRU equal to "SECOND " or "NSTEP ".

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr style="width: 100%; border: 0; border-top: 1px solid green; margin: 5px 0;"/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 463/851

149

## PUMPCHAR OPERATOR

The **PUMPCHAR** operator creates a PUMPCHAR object, defining the characteristics of the 0D pump.

In the present version, an asynchronous motor model is available. This model is automatically used by **CATHARE** if the keyword ELEC is given after the MOTOR keyword.

If the keyword EXTERNAL is given after MOTOR keyword, the motor torque will be given by CCV (**COMETE** application).

### Associated Keywords

PCAVIT, BLKROTOR, PUMPMOD, STOPPUMP, STARPUOMP, POUNC, VALUE FOR PUMP, WRITE FOR PUMP

**Remark :**

The operating octants are defined as follows (the 7th and 8th octants are not described in Cathare):

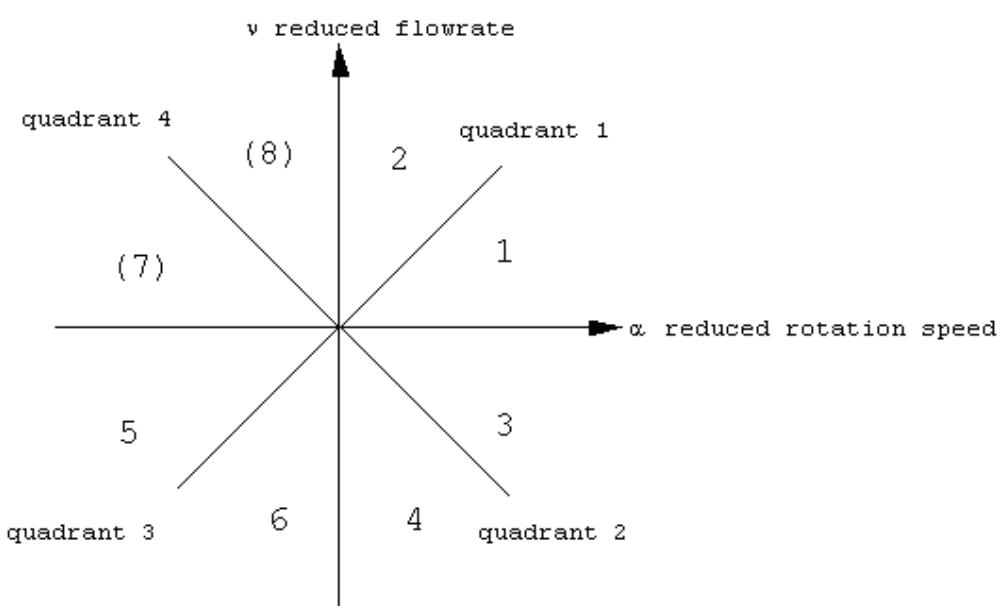


Figure 149.0.1: PUMPCHAR : operating octants



## Syntax

char= **PUMPCHAR** elem pi **TYPNAME**

### **case where TYPNAME = FREE**

<b>OCTANT</b>	num1						
<b>NOCTP</b>	n1						
<b>NUALF</b>	z1	...		zn1			
<b>DHEIGHT</b>	n2	<b>HOMH</b>		z'1			
			...		z'n1		
<b>DTORQUE</b>	n3	<b>HOMTORQ</b>	z"1			z'"n1	
			...				
							<b>to be repeated for each of the 6 octants</b>

**(DEGRADE**

**case where TYPNAME = FREE**

<b>OCTANT</b>	num1						
<b>NOCTP</b>	n1						
<b>NUALF</b>	z1...	zn1					
<b>DHEIGHT</b>	n2	<b>HOMH</b>	z'1				
			...		z'n1		
<b>DTORQUE</b>	n3	<b>HOMTORQ</b>	z''1				
			...		z''n1		
<b>DEGRNB</b>	i1						
<b>ALFA</b>	t1	...	ti1				
<b>DEGRH</b>	u1	...	ui1				
<b>DEGRTORO</b>	v1	...	vi1 )				

### (CAVITANT

case where TYPNAME = FREE

<u>case where ITYPNAME = FREE</u>				to be repeated for each of the 2 octants
OCTANT	num1			
NOCTP	n1			
NUALF	z1...	zn1		
DHEIGHT	n2	HOMH	z'1 z'n1	
DGCAVN B	i1			
ALFA	t1	...	ti1	
DEGRCAV	u1	...	ui1 )	

case where TYPNAME = PEM

## case w

<b>LENGTH</b>	len1
<b>TENSION</b>	<b>VALUE</b> tens1
	or
	<b>IMPOSED</b> law1

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 465/851

**GAIN** gain1  
**GAIN** gain1

or

**PLANE**

<b>LENGTH</b>	len1			
<b>TENSION</b>	<b>VALUE</b>	tens1		
	or		<b>IMPOSED</b>	law1
<b>GAIN</b>	gain1			
<b>FREQUEN</b>	freq1			
<b>WAVELENG</b>	lamb1			
<b>ENTREFER</b>	ent1			

or

**ANNULAR**

<b>LENGTH</b>	len1			
<b>TENSION</b>	<b>VALUE</b>	tens1		
	or		<b>IMPOSED</b>	law1
<b>GAIN</b>	gain1			
<b>FREQUEN</b>	freq1			
<b>WAVELENG</b>	lamb1			
<b>FORMFACT</b>	form1			

**MOTOR**

**EXTERNAL**

or **TORQUE** z1 z2 z3

or

**NOTORQUE**

or **ELEC** **(to be used for asynchronous motor model)**

reactor-type	pump-type			
rm lm	rs rr0	$\alpha$	$L$	$\beta$
<b>TENSION</b>	x1			
<b>FREQUEN</b>	x2			

**INERTIA** z4

**VELOCITY**

	<b>RPM</b>	z5				
or	<b>RADSEC</b>	z5				
or	<b>ROTATION</b>	<b>RPM</b>	z6	z7		
or	<b>ROTATION</b>	<b>RADSEC</b>	z6	z7		
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RPM</b>	z6	<b>RPM</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RPM</b>	z6	<b>RADSEC</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RPM</b>	z6	<b>NORMAL</b>	z7
						lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RADSEC</b>	z6	<b>RPM</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RADSEC</b>	z6	<b>RADSEC</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RADSEC</b>	z6	<b>NORMAL</b>	z7
						lawj

<b>FRICITION</b>	z8	z9	z10	z11		
<b>PUMP</b>	<b>NOMV</b>	z12	<b>NOMFLOW</b>	z13	<b>GRAVH</b>	z14
			<b>PUMPDP</b>	z15		
	<b>NOMTORQ</b>	z16	;			
or	<b>NOMTORQ</b>	z16	<b>DISCRET</b>	<b>ROMOY</b>	z17	;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 466/851

**elem** : axial element name  
**pi** : vector point to which the pump is to be assigned.  
**typname** : keyword defining the type of pump.  
 For standard pump :  
 Predefined characteristics are defined in the public libraries for following *typname* pumps: **LOFT**, **LOBI**.  
 The following *typname* pumps characteristics are defined in private libraries: **CP1**, **N4**, **P4**, **RRA**, **BETHSY**, **EVA** and **EPR**.  
 Else the keyword to use is **FREE** and the user has to define his own characteristics.  
 For electromagnetic pump (**PEM**) : User can use the typename **PEM** to define an electromagnetic pump. Different models of electromagnetic pumps are available: flat or annular linear induction pumps, proportional pump (simplified model where flowrate is proportional to voltage).

**NB** : the keyword NOPFREE is allowed for compatibility with old input decks and has exactly the same meaning as FREE for the code. Whatever keyword is used no plots of pump characteristics is made

In the case of **FREE**, the following data is entered for each of the 6 octants :

By definition :

$v$  = volume flowrate/nominal volume flowrate  
 $\alpha$  = rotation speed/nominal rotation speed  
 $h$  = head/nominal head  
 $\beta$  = specific torque/nominal specific torque

By convention the following are used:

$$\left| \frac{\alpha}{v} \right| \leq 1 : z = \frac{\alpha}{v}; z' = \frac{h}{v^2}; z'' = \frac{\beta}{v^2}$$

and

$$\left| \frac{\alpha}{v} \right| > 1 : z = \frac{v}{\alpha}; z' = \frac{h}{\alpha^2}; z'' = \frac{\beta}{\alpha^2}$$

**OCTANT num1** : keyword followed by an integer  $1 \leq \text{num1} \leq 6$ , indicating the number of the octant for which the data are being entered.  
**NOCTP n1** : keyword followed by an integer  $1 \leq n1 \leq 20$  defining the number of points in the octant.  
**NUALF** : keyword indicating that the values of  $z = n/a$  or  $z = a/n$  (see above by definition), depending on the octant, are to be read for each point of the octant. This is followed by :  
**z1 ...zn1** :  $n1$  real numbers in range  $[-1.,+1.]$  representing the values of  $z$  in increasing order of absolute values.  
**DHEIGHT n2** : keyword followed by an integer  $2 \leq n2 \leq 7$  defining the degree of the head polynomial in the octant.  
**HOMH** : keyword indicating that the values of  $z'' = \frac{\beta}{v^2}$  or  $z' = \frac{h}{\alpha^2}$  (see above by definition), depending on the octant, for each point of the octant are given. This is followed by :  
**z'1 ...z'n1** :  $n1$  real numbers representing the values of  $z'$ .  
**DTORQUE n3** : keyword followed by an integer  $2 \leq n3 \leq 7$ , defining the degree of the torque polynomial in the octant.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 467/851

<b>HOMTORQ</b> <b>z”1 ... z”n1</b> <b>DEGRADE</b>	<p>: keyword indicating that the <math>z''</math> values <math>z'' = b/n2</math> or <math>z'' = b/a2</math> (see above by definition), depending on the octant for each point in the octant are given. This is followed by :</p> <p>: <math>n1</math> real numbers representing the values of <math>z''</math>.</p> <p>: OPTIONAL keyword indicating that the user wants to use degraded pump characteristics.</p>
<b>OCTANT num2</b>	<p>In the case of <b>FREE</b> the keyword <b>DEGRADE</b> is followed by the following data <u>for each of the 6 octants</u> :</p> <p>: keyword followed by an integer <math>1 \leq num2 \leq 6</math>, indicating the number of the octant for which the data are being entered.</p>
<b>NOCTP m1</b>	<p>: keyword followed by an integer <math>1 \leq m1 \leq 20</math> defining the number of points in the octant.</p>
<b>NUALF</b>	<p>: keyword indicating that the values of <math>y = \frac{v}{\alpha}</math> or <math>y = \frac{\alpha}{v}</math> (see above by definition), depending on the octant, are to be read for each point of the octant. This is followed by :</p>
<b>y1 ... ym1</b>	<p>: <math>m1</math> real numbers in range [-1.,+1.] representing the values of <math>y</math> in increasing order of absolute values.</p>
<b>DHEIGHT m2</b>	<p>: keyword followed by an integer <math>2 \leq m2 \leq 7</math> defining the degree of the head polynomial in the octant.</p>
<b>HOMH</b>	<p>: keyword indicating that the values of <math>y' = \frac{h}{v^2}</math> or <math>y' = \frac{h}{\alpha^2}</math> (see above by definition), depending on the octant, for each point of the octant are given. This is followed by :</p>
<b>y’1 ... y’m1</b>	<p>: <math>m1</math> real numbers in range [-1.,+1.] representing the values of <math>y'</math>.</p>
<b>DTORQUE m3</b>	<p>: keyword followed by an integer <math>2 \leq m3 \leq 7</math> defining the degree of the torque polynomial in the octant.</p>
<b>HOMTORQ</b>	<p>: keyword indicating that the values of <math>y'' = \frac{\beta}{v^2}</math> or <math>y'' = \frac{\beta}{\alpha^2}</math> (see above by definition), depending on octant, for each point in the octant are given. This is followed by :</p>
<b>y”1 ... y”m1</b>	<p>: <math>m1</math> real numbers representing the values of <math>y''</math>.</p>
<p>The following data is then read :</p>	
<b>DEGRNB i1</b>	<p>: keyword followed by an integer <math>&gt; 0</math> defining the number of points (<math>\leq 20</math>) for the degradation function.</p>
<b>ALFA</b>	<p>: keyword indicating that the values of the void fractions are to be read. This is followed by :</p>
<b>t1 ... ti1</b>	<p>: <math>i1</math> real numbers <math>\geq 0</math> representing the void fractions.</p>
<b>DEGRH</b>	<p>: keyword indicating that the values of the head degradation function are to be read. This is followed by :</p>
<b>u1 ... ui1</b>	<p>: <math>i1</math> real numbers representing the values of the head degradation function.</p>
<b>DEGRTORQ</b>	<p>: keyword indicating that the values of the torque degradation function are to be read. This is followed by :</p>
<b>v1 ... vi1</b>	<p>: <math>i1</math> real numbers representing the values of the torque degradation function.</p>
<b>CAVITANT</b>	<p>: OPTIONAL keyword indicating that the user wants to enhance the pump degradation taking into account the pump cavitation.</p>
<p>In the case of <b>FREE</b> the keyword <b>CAVITANT</b> is followed by the following data given <u>for each of two first octants</u> :</p>	
<b>num2</b>	<p>: keyword followed by an integer <math>1 \leq num2 \leq 2</math>, indicating the number of the octant for which the data are being entered.</p>
<b>NOCTP m1</b>	<p>: keyword followed by an integer <math>1 \leq m1 \leq 20</math> defining the number of points in the octant.</p>
<b>NUALF</b>	<p>: keyword indicating that the values of <math>y = \frac{v}{\alpha}</math> or <math>y = \frac{\alpha}{v}</math> (see above by definition), depending on octant, are to be read for each point of the octant. This is followed by :</p>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 468/851

**y1 ...ym1** : m1 real numbers in range [-1.,+1.] representing the values of y in increasing order of absolute values.

**DHEIGHT m2** : keyword followed by an integer  $2 \leq m2 \leq 7$  defining the degree of the head polynomial in the octant.

**HOMH** : keyword indicating that the values of  $y' = \frac{h}{v^2}$  or  $y' = \frac{h}{g^2}$  (see above by definition), depending on the octant, for each point of the octant are given. This is followed by :

**y'1 ...y'm1** : m1 real numbers in range [-1.,+1.] representing the values of  $y'$ .

The following are then read :

**DGCAVNB i1** : keyword followed by an integer  $> 0$  defining the number of points for the cavitation function.

**ALFA** : keyword indicating that the values of the npsh<sup>1</sup> are to be read. This is followed by :

**t1 ...ti1** : real numbers  $\geq 0$ . representing the npsh (\*).

**DEGCAV** : keyword indicating that the values of the cavitation function are to be read. This is followed by :

**u1 ...ui1** : real numbers representing the values of the cavitation function.

In the case of **PEM**:

**PROP** : keyword indicating that a proportional electromagnetic pump is used. This model is a simplified model where flowrate is proportional to voltage

**LENGTH len1** : real number representing the length of electromagnetic pump (m)

**TENSION** : keyword defining the power supply alternating voltage of the pump (V).

This if followed by :

**VALUE tens1** : keyword followed by a real number defining the value pump voltage

**or** : keyword followed by a law defining the evolution of pump voltage versus time.

**IMPOSED law1**

**GAIN gain1**

: keyword indicating the constant of proportionality between pressure drop and pump voltage

Or

**PLANE**

**LENGTH len1** : keyword indicating that a flat linear induction pump is used.

**TENSION** : real number representing the length of electromagnetic pump (m)

: keyword defining the power supply alternating voltage of the pump (V).

This if followed by :

**VALUE tens1** : keyword followed by a real number defining the value of pump voltage

**or** : keyword followed by a law defining the evolution of pump voltage versus time.

**IMPOSED law1**

**GAIN gain1**

: keyword indicating the constant of proportionality between pressure drop and pump voltage

**FREQUEN freq1** : keyword defining the power supply voltage frequency of the pump (Hz)

**WAVELENG lamb1** : keyword followed by a real number defining the wavelength of the electromagnetic field (m)

**ENTREFER ent1** : keyword followed by a real number defining the channel width (m)

Or

**ANNULAR**

**LENGTH len1** : keyword indicating that an annular linear induction pump is used.

**TENSION** : real number representing the length of electromagnetic pump (m)

: keyword defining the power supply alternating voltage of the pump (V).

This if followed by :

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 469/851

<b>VALUE</b> tens1 or <b>IMPOSED</b> law1 <b>GAIN</b> gain1 <b>FREQUEN</b> freq1 <b>WAVELENG</b> lamb1  <b>FORMFACT</b> form1  <b>MOTOR</b> <b>EXTERNAL</b> or <b>TORQUE</b> <b>z1 z2 z3</b>  or <b>NOTORQUE</b>  or <b>ELEC</b> <b>planttype</b> <b>pumptype</b> Or <b>rm</b> <b>lm</b> <b>rs</b> <b>rr0</b> $\alpha$ <b>L</b> $\beta$ $\gamma$	<p>: keyword followed by a real number defining the value pump voltage</p> <p>: keyword followed by a law defining the evolution of pump voltage versus time.</p> <p>: keyword indicating the constant of proportionality between pressure drop and pump voltage</p> <p>: keyword defining the power supply voltage frequency of the pump (Hz)</p> <p>: keyword followed by a real number defining the wavelength of the electromagnetic field (m)</p> <p>: keyword followed by a real number defining the electromagnetic field form factor</p> <p>: keyword indicating that data concerning the motor itself are to be read. This is followed by :</p> <p>: keyword indicating that the motor torque is given by CCV (<b>COMETE</b> application)</p> <p>: keyword indicating that the coefficients of the motor torque function are to be read. This is followed by :</p> <p>: real numbers representing the coefficients of the motor torque function and depending on voltage.</p> <p><b>NB</b> : The torque applied on the shaft by the motor for asynchronous motors is classically given by the reduced formula :</p> $Cm = \frac{Cr \cdot g \cdot (z1 + z2 \cdot G)}{((z3 \cdot g)^2 + (z1 + z2 \cdot G)^2)} = Cr \cdot F(g)$ <p>With :</p> <p><math>Cm</math> = motor torque</p> <p><math>Cr</math> = nominal motor torque multiplier calculated by the code after the steady state <math>Cr = \frac{Cf + Ch}{F(g)}</math> with <math>Cf</math> friction torque and <math>Ch</math> hydraulic torque</p> <p><math>g</math> = dynamic slip <math>g = 1 - \frac{om}{oms}</math></p> <p><math>om</math> = pump rotation speed</p> <p><math>oms</math> = synchronism pump speed (for example 1500 rpm)</p> <p><math>G =  g </math></p> <p>: keyword indicating that the coefficients of the motor torque function are not given. In this case, the rotation speed must be <u>imposed</u> by a law. Then the options VELOCITY RPM z5, VELOCITY RADSEC z5, VELOCITY ROTATION RPM z6 z7, VELOCITY ROTATION RADSEC z6 z7 are forbidden. Furthermore, no computation of pump rotation speed is performed by the code.</p> <p>: keyword indicating that an asynchronous motor model characteristics are to be read. This is followed by :</p> <p>: standardized plant type CP1, CP2, P4, P4', N4 and EPR.</p> <p>: standardized pump type RRA or RCP.</p> <p>: real number representing the magnetic resistance</p> <p>: real number representing the magnetic inductance</p> <p>: real number representing the Joules resistance</p> <p>: real number representing the rotor resistance</p> <p>: constant of the model</p>
---	---

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 470/851</a>

**NB :** Default values for  $\alpha$ ,  $L$ ,  $\beta$ ,  $\gamma$  can be found in « Modèle de moteur électrique pour CATHARE2 V1.5 » (SMTH/LMTEL/EM/97-031 p71).

**TENSION t1**  
**FREQUEN f2**

: real number representing the reference supply voltage  
: real number representing the reference supply frequency

**INERTIA z4**

: keyword followed by a real number  $> 0.$ , representing the inertia of the motor in kg.m<sup>2</sup>.

**VELOCITY**

: keyword indicating that the synchronism pump speed values are given. This is followed by :

**RPM z5**

: keyword followed by a real number  $> 0.$ , representing the synchronism pump speed (rpm).

or

**RADSEC z5**

: keyword followed by a real number  $> 0.$ , representing the synchronism pump speed (rad/s).

or

**ROTATION**

: keyword indicating that the pump rotation speed for the steady computation or for the transient computation is imposed. This is followed by :

**RPM**

: keyword indicating that the pump speed values in (rpm) are given. This is followed by :

**z6**

: real number  $> 0.$ , representing the synchronism pump speed (rpm).

**z7**

: real number  $\geq 0.$ , representing the pump rotation speed (rpm).

or

**RADSEC**

: keyword indicating that the pump speed values in (rad/s) are given. This is followed by :

**z6**

: real number  $> 0.$ , representing the synchronism pump speed (rad/s).

**z7**

: real number  $> 0.$ , representing the pump rotation speed (rad/s).

or

**IMPOSED**

: keyword indicating that a law governing pump rotation speed as a function of time is defined. This is followed by :

**RPM**

: keyword indicating that the synchronism pump speed is given. This is followed by :

**z6**

: real number  $> 0.$ , representing the synchronism pump speed (rpm).

or

**RADSEC**

: keyword indicating that the synchronism pump speed is given. This is followed by :

**z6**

: real number  $> 0.$ , representing the synchronism pump speed (rad/s).

After defining the synchronism pump speed in the case of IMPOSED, the user then defines the law governing variations in pump rotation speed. The following are then read :

**RPM**

: keyword indicating that the user wishes to read the ‘TIME’ ‘ROTV’ law governing changes in speed as a function of time with the pump rotation speed values (rpm) is defined. This is followed by :

**lawj**

: law object defining the change in pump rotation speed as a function of time. The number of points in the law is limited to 100.

or

**RADSEC**

: keyword indicating that the “TIME” ‘ROTV’ law governing changes in speed as a function of time with the pump rotation speed values in (rad/s) is defined. This is followed by :

**lawj**

: law object defining the change in pump rotation speed as a function of time. The number of points in the law is limited to 100.

or

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 471/851</a>

<b>NORMAL</b>	: keyword indicating that the normalized “TIME” ‘ROTV’ law governing changes in speed as function of time is defined. This is followed by :
<b>z7 lawj</b>	: normalization coefficient for pump speed rotation. This is followed by : : law object defining the change in pump rotation speed as a function of time. The number of points in the law is limited to 100.
<b>FRICITION</b>	: keyword indicating that the coefficients of the friction torque law, included in the shaft equation only, are given. This is followed by :
<b>z8 z9 z10 z11</b>	: four real numbers representing the friction coefficients.
	<b>NB</b> : The friction torque Cf : $Cf = z8 + z9 \cdot OM + z10 \cdot OM \cdot  OM  + z11 \cdot Pressure$ in which <i>OM</i> is the rotation speed (rad/s), <i>Cf</i> (Nm), <i>Pressure</i> (Pa).
<b>PUMP</b>	: keyword indicating that the data relating to the pump itself are given. This is followed by :
<b>NOMV z12</b>	: keyword followed by a real number > 0., representing the reference pump rotation speed (rpm).
<b>NOMFLOW z13</b>	: keyword followed by a real number > 0., representing the reference volume flowrate (m <sup>3</sup> /s).
<b>GRAVH z14</b>	: keyword followed by a real number > 0., representing the reference head multiplied by gravity (m <sup>2</sup> /s <sup>2</sup> ).
or <b>PUMPDP z15</b>	: keyword followed by a real number > 0., representing the pressure difference (Pa) ( <b>COMETE</b> application)
<b>NOMTORQ z16</b>	: keyword followed by a real number > 0., representing the reference specific torque (m <sup>5</sup> /s <sup>2</sup> ). <b>NB</b> : Specific torque = torque/specific mass
<b>DISCRET</b>	: keyword indicating that the average density is given ( <b>COMETE</b> application)
<b>ROMOY z17</b>	: keyword followed by a real number > 0., representing the density value ( <b>COMETE</b> application)

### Examples

1)  
CARPOMI = PUMPCHAR froide1 pi LOFT DEGRADE  
MOTOR TORQUE 7.4D-3 2.33E-2 . 172E0  
INERTIA 3.70D3  
VELOCITY RPM 1495.2  
FRICTION 4.65 0. 0. 6.475E-6  
PUMP NOMV 1485.4 NOMFLOW 5.853  
GRAVH 1020.9 NOMTORQ 42.65 ;

2)  
CARPOM2 = PUMPCHAR froide1 pi CP1  
MOTOR EXTERNAL

<sup>1</sup>**NPSH**: Net Positive Section Head

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 472/851</a>

INERTIA	3.70D3
VELOCITY	RPM                  1495.2
FRICTION	4.65                  0.                  0.                  6.475E-6
PUMP	NOMV                  1485.4                  NOMFLOW          5.853
	PUMPDP                  20.D5                  NOMTORQ        42.65
DISCRET	ROMOY                  850.D0 ;

3)

CARPOM2 =	PUMPCHAR                  froidel                  pi                  CP1
DEGRADE	CAVITANT
MOTOR	ELEC                  CP1                  RRA
TENSION	6600.
FREQUEN	50.
INERTIA	3.70D3
VELOCITY	RPM                  1495.2
FRICTION	4.65                  0.                  0.                  6.475E-6
PUMP	NOMV                  1485.4                  NOMFLOW        5.853
GRAVH	1020.9                  NOMTORQ        42.65 ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 473/851

150

## PUMPMOD DIRECTIVE

The **PUMPMOD** directive is used to modify the characteristics of a 0D-pump during a transient, in the *command block*.

### Associated Keywords

PUMPCHAR, PCAVIT, BLKROTOR, STOPPUMP, STARPUMP, POUNC

### Syntax

<b>PUMPMOD</b>	<b>char</b>	<b>FREE</b>	
<b>OCTANT</b>	<b>num</b>		
<b>NOCTP</b>	<b>m1</b>		
<b>NUALF</b>	<b>y1</b>	<b>...</b>	<b>ym1</b>
<b>DHEIGHT</b>	<b>m2</b>	<b>HOMH</b>	<b>y'1 ...</b>
<b>DTORQUE</b>	<b>m3</b>	<b>HOMTORQ</b>	<b>y"1 ...</b>
or			<b>y'm1;</b>
<b>PUMPMOD</b>	<b>char</b>	<b>DEGRADE</b>	<b>FREE</b>
<b>OCTANT</b>	<b>num2</b>		
<b>NOCTP</b>	<b>m1</b>		
<b>NUALF</b>	<b>y1</b>	<b>...</b>	<b>ym1</b>
<b>DHEIGHT</b>	<b>m2</b>	<b>HOMH</b>	<b>y'1 ...</b>
<b>DTORQUE</b>	<b>m3</b>	<b>HOMTORQ</b>	<b>y"1 ...</b>
<b>DEGRNB</b>	<b>i1</b>		
<b>ALFA</b>	<b>t1</b>	<b>...</b>	<b>ti1</b>
<b>DEGRH</b>	<b>u1</b>	<b>...</b>	<b>ui1</b>
<b>DEGRTORQ</b>	<b>v1</b>	<b>...</b>	<b>vi1 ;</b>
or			
<b>PUMPMOD</b>	<b>char</b>	<b>CAVITANT</b>	<b>FREE</b>
<b>OCTANT</b>	<b>num2</b>		
<b>NOCTP</b>	<b>m1</b>		
<b>NUALF</b>	<b>y1...</b>		<b>ym1</b>
<b>DHEIGHT</b>	<b>m2</b>	<b>HOMH</b>	<b>y'1 ...</b>
<b>DGCAVNB</b>	<b>i1</b>		<b>y'm1</b>
<b>ALFA</b>	<b>t1...</b>	<b>ti1</b>	
<b>DEGRCAV</b>	<b>u1</b>	<b>...</b>	<b>ui1 ;</b>
or			
<b>PUMPMOD</b>	<b>char</b>	<b>ROTATION</b>	

<b>RPM</b>	<b>ABSOLUTE</b>	list1
	or	
	<b>RELATIVE</b>	list1
	<b>ROTV</b>	list2 ;
or		
<b>RADSEC</b>	<b>ABSOLUTE</b>	list1
	or	
	<b>RELATIVE</b>	list1
	<b>ROTV</b>	list2 ;
or		
<b>NORMAL z7</b>	<b>ABSOLUTE</b>	list1
	or	
	<b>RELATIVE</b>	list1
	<b>ROTV</b>	list2 ;
or		
<b>PUMPMOD</b>	<b>char</b>	<b>CALROTA :</b>

<b>char</b>	: name of the OD pump which characteristics will be modified.
<b>FREE</b>	: keyword defining the type of pump and followed by the pump characteristics for each 6 octants.
<b>DEGRADE FREE</b>	: keyword defining the type of pump and followed by the pump characteristics for each 6 octants in the degraded mode.

a) : in case of **FREE** or **DEGRADE FREE**, the following data for each of the 6 octants is read :

**OCTANT num2** : keyword followed by an integer  $1 \leq \text{num2} \leq 6$ , indicating the number of the octant for which the data are being entered

**NOCTP m1** : keyword followed by an integer  $1 \leq m1 \leq 20$  defining the number of points in the octant.

**NUALF** : keyword indicating that the values of  $y = \frac{v}{\alpha}$  or  $y = \frac{\alpha}{v}$ , depending on octant, are to be read for each point of the octant. This is followed by :

**y1 ... ym1** : m1 real numbers representing the values of y in increasing order of absolute values.  
**DHEIGHT m2** : keyword followed by an integer  $2 \leq m2 \leq 7$  defining the degree of the head polynomial.

**HOMH** : keyword indicating that the values of  $y' = \frac{h}{\sqrt{2}}$  or  $y' = \frac{h}{\sqrt{2}} - 1$ , depending on the octant for

$y'1 \dots y'm1$  each point of the octant are given. This is followed by:  
 $m1$  real numbers representing the values of  $y'$ .

**DTORQ m3** : keyword followed by an integer > 1 and < 8, defining the degree of the torque polynomial in the octant.

**HOMTORQ** : keyword indicating that the values of  $y'' = \frac{\beta}{y^2}$  or  $y'' = \frac{\beta}{\alpha^2}$ , depending on the octant for each point of the octant are given. This is followed by:

**y”1 ... y”m1** : m1 real numbers representing the values of y”.

$\alpha$	= rotation speed/nominal rotation speed
$h$	= head/nominal head
$\beta$	= specific torque/nominal specific torque

**b)  
DEGRNB i1** In case of **DEGRADE FREE**, the complementary following data is then read:  
: keyword followed by an integer  $> 0$  defining the number of points ( $\leq 20$ ) for the degradation function.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
<b>Document technique DEN</b>	Page 475/851

<b>ALFA t1 ... ti1</b> <b>DEGRH u1 ... ui1</b> <b>DEGRTORQ v1 ... vi1</b> <b>CAVITANT FREE</b> <b>a)</b> <b>OCTANT num2</b> <b>NOCTP m1</b> <b>NUALF</b> <b>y1 ... ym1</b> <b>DHEIGHT m2</b> <b>HOMH</b> <b>y'1 ... y'm1</b>  <b>v</b> <b>α</b> <b>h</b> <b>β</b>  <b>b)</b> <b>DGCAVN B i1</b> <b>ALFA</b> <b>t1 ... ti1</b> <b>DEGRCAV</b> <b>u1 ... ui1</b> <b>ROTATION</b> <b>RPM</b> <b>or RADSEC</b> <b>or NORMAL z7</b> <b>ABSOLUTE</b>  <b>list1</b> <b>ROTV</b> <b>list2</b>	: keyword indicating that the values of the void fractions are to be read. This is followed by real numbers $\geq 0$ . representing the void fractions. : keyword indicating that the values of the head degradation function are to be read. This is followed by real numbers representing the values of the head degradation function. : keyword indicating that the values of the torque degradation function are to be read. This is followed by real numbers representing the values of the torque degradation function. : keyword defining the type of pump and followed by the cavitation characteristics for the 2 first octants. case of <b>CAVITANT FREE</b> , the following data <u>for each of the 2 octants</u> is read : : keyword followed by an integer $1 \leq \text{num2} \leq 2$ , indicating the number of the octant for which the data are being entered : keyword followed by an integer $1 \leq m1 \leq 20$ defining the number of points in the octant. : keyword indicating that the values of $y = \frac{v}{\alpha}$ or $y = \frac{\alpha}{v}^{-1}$ , depending on octant, are to be read for each point of the octant. This is followed by : : $m1$ real numbers representing the values of $y$ in increasing order of absolute values. : keyword followed by an integer $2 \leq m2 \leq 7$ defining the degree of the head polynomial in the octant. : keyword indicating that the values of $y' = \frac{h}{v^2}$ or $y' = \frac{h}{\alpha^2}^{-1}$ , depending on the octant for each point of the octant are given. This is followed by: : $m1$ real numbers representing the values of $y'$ .  = volume flowrate/nominal volume flowrate = rotation speed/nominal rotation speed = head/nominal head = specific torque/nominal specific torque  The following are then read: : keyword followed by an integer $> 0$ defining the number of points for the cavitation function. : keyword indicating that the values of the npsh <sup>2</sup> are to be read. This is followed by : : real numbers $\geq 0$ . representing the npsh <sup>2</sup> . : keyword indicating that the values of the cavitation function are to be read. This is followed by : : real numbers representing the values of the cavitation function.  : keyword indicating that the pump rotation speed is imposed. This is followed by : : keyword indicating that the pump rotation speed values will be given in (rpm) : keyword indicating that the pump rotation speed will be given in (rad/s) : keyword indicating that the pump rotation speed values are going to be normalized. It is followed by the normalisation coefficient for pump speed rotation. : keyword used for defining the absolute time in the pump rotation speed variation law. If the relative time is considered, the word ABSOLUTE will be replaced by the word RELATIVE. : realist defined with the keyword REALLIST followed by a list of time values (s). : keyword specifying that the pump velocity values are to be given. : realist defined with the keyword REALLIST followed by the pump rotation speed variations function of time.
---	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 476/851

**CALROTA** : keyword indicating that the pump rotation speed is calculated, instead of imposing it (power supply of the pump is open). This option is used when, for example after performing a steady state calculation by transient with regulations, the user wants to calculate the pump rotation speed and not impose it anymore. When this command is used, the code recalculates automatically the nominal motor torque “Cr” (see **PUMPCHAR** operator).

#### Example

```

PUMPMOD    char1      ROTATION   RPM
          ABSOLUTE
          ROTV        REALIST    x1         x2         ...         xn
          ROTV        REALIST    y1         y2         ...         yn ;
PUMPMOD    char1      CALROTA ;

```

**NB** : This directive generates several calls to the FORTRAN subroutines RPMOD0, RPMOD1, RPMOD2, RPMOD3.

<sup>1</sup>For more information, see **PUMPCHAR** operator

<sup>2</sup>NPSH : Net Positive Section Head

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 477/851

151

## QUIT DIRECTIVE

The **QUIT** directive is used to interrupt the execution of an instruction block of the data set.

Control is then passed to the line immediately following the end of the block. Used in the *command block*.

<b>Associated Keywords</b>
----------------------------

REPEAT, END, IF, ENDIF, ELSE, AND, OR

<b>Syntax</b>
---------------

```

REPEAT      blockm      nsteps      ;  

...  

IF          condition    ;  

...  

QUIT        blockm      ;  

ENDIF       ;  

END         blockm      ;

```

**if the blocks are interleaved**

```

REPEAT      block1      mpas       ;  

REPEAT      block2      mpas       ;  

...  

IF          condition    ;  

...  

ELSE        ;  

...  

QUIT        block1      ;  

ENDIF       ;  

END         block2      ;  

END         block1      ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 478/851

<b>Example</b>
----------------

```

nsteps =      500          ;
REPEAT        block         nsteps       ;
                  time=        time        + dt      ;
                  if (time >      tmax)      ;
                  QUIT         block       ;
                  endif        ;
                  TRANSIENT    c1          time        dt       ;
                  ...           block       ;
END

```

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 479/851

# 152

## RADCHEMI OPERATOR

The **RADCHEMI** operator used in the *data block* creates an object of radio-chemical type, by defining the radio-chemical components carried in a circuit. This object will be used during construction of the circuit.

The maximum number of radio-chemical components is 12.

Acquisition of radio-chemical component characteristics must be specified for each circuit.

There are 13 radio-chemical components whose characteristics are pre-defined in **CATHARE** and there is also the possibility to define new user-defined components by giving characteristics as follow.

The description and treatment of radio-chemical components is given in the User manual and the User guideline **CATHARE2** documents.

**NB :** These properties are common to all the elements of the circuit. Some of them may be changed in particular elements via WRITE/WRIBA (refer to these directives) or INIBORA.

### Associated Keywords

ACTEMIS, SCRAM, WRIBA, VALBA, WCIRCBA, ACCU, INIBORA, GOBORA, ZONBAMOY, NONCOND, CORE, CIRCUIT, REACTOR

### Syntax

```

radelem= RADCHEMI i1
      elnam1   or      COMPO01
                  ira      vie      ka
                  henry    ke       kc
                  dilu     degaz   relach
                  imr      mult   ratio
                  idp      puis   loid
                  loim     effi
      elnam2   or      COMPO02
                  ...
      ...
      elnami1  or      COMPO11
                  ...
;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 480/851

<b>radelem</b>	: name of the radio-chemical type object.
<b>i1</b>	: integer equal to the total number of radio-chemical components expected in the circuit ( $1 \leq i1 \leq 12$ ).
<b>Elnam1</b>	: name of a radio-chemical component which properties are predefined in <b>CATHARE</b> (subroutine RPROBA). This keyword may have any of the following values.
<b>...elnami1</b>	
<b>Keyword</b>	<b>component type</b>
KRYPTO87	KRYPTON 87
XENON133	XENON 133
IODE131	IODINE 131
CESIU137	CESIUM 137
AZOTE16	NITROGEN 16
COBAMANG	COBALT 60 / MANGANESE
BORON	BORON
HPLUS	PH (ION H <sup>+</sup> )
CONDUCTI	CONDUCTIVITY
OXYGENO2	OXYGEN O <sub>2</sub>
SODIUMNA	SODIUM Na
HYDRAZIN	HYDRAZINE N <sub>2</sub> H <sub>4</sub>
AZOTE N2	NITROGEN N <sub>2</sub>
<b>or</b>	
<b>COMPOxx</b>	: name of a the new radio-chemical component, ending by 2 characters which must be chosen by the user (01, 02, ..., 12). This keyword is followed by :
<b>ira</b>	: integer defining the nature of the component : · 0 ⇒ non gaseous – non radioactive · 1 ⇒ non gaseous – radioactive · 2 ⇒ gaseous – radioactive · 3 ⇒ gaseous – non radioactive
<b>vie</b>	: real number $\geq 0$ . representing the half-life of the radio-active component expressed in seconds.
<b>ka</b>	: real number to set the weight of one Gbq (kg). For a chemical component this constant is equal to 1.
<b>henry</b>	: real number to set the Henry constant for a gas (= 1, else) (units : Pa).
<b>ke</b>	: real number to set the entrainment coefficient due to vaporization.
<b>kc</b>	: real number to set the entrainment coefficient due to condensation.
<b>dilu</b>	: real number to set the gas into liquid dissolution time constant (s).
<b>degaz</b>	: real number to set the time constant associated to the gas stripping (s).
<b>relach</b>	: real number to set the emission rate in GBq before the Emergency Shutdown (fission products) or ratio coefficient between this rate of emission and the neutronic flow (depend on <b>imr</b> value, see below).
<b>imr</b>	: integer equal to 0 if the relach rate is used, 1 otherwise.
<b>mult</b>	: real number defining an amplifying factor for the rate of emission after Emergency Shutdown (available during all the peak duration): equal to 1 if activation product or radiolysis product exists. Not used if chemical component.
<b>ratio</b>	: real number giving either the ratio between the mean specific activity in primary circuit aimed at the end of the peak and those observed before Emergency Shutdown ; or the peak duration (depend on the <b>idp</b> value, see below).
<b>idp</b>	: integer equal to 1 if peak duration is used, 0 else. If activation product or radiolysis product or radio-chemical components, idp = 1 .
<b>puis</b>	: data not used, =1.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 481/851

- loid** : name of the law giving the activity quantity in the core (GBq), function of the elapsed time since Emergency Shutdown ; this quantity is only related to the activity existing between  $\text{UO}_2$  pellets and the cladding. This quantity of activity should be equal to 0 in case of activation product or radiolysis product (no fission product in the cladding-pellet space), chemical components in the same way.  
**Loid** = LAW ‘ABSTIME’ ‘DECREASE’ .... ;
- loim** : name of the law giving the maximum value of the concentration in the liquid phase function of the liquid temperature. **Loim** = LAW ‘TEMPER’ ‘MAXL’ .... ;
- effi** : real number used to model the efficiency relative to the component of the Chemical and Volume Control filters. **Effi** = 1.0 means that the filters are completely inoperative. **Effi** should be > 1.0 for operative filters.

<b>Example</b>
----------------

```
RADDEF =      RADCHEMI    2
              BORON       XENON133    ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 482/851

153

## RADIAN OPERATOR

The RADIANT operator is used to convert the measure of an angle from degree to radian. The result is a real number (DOUBLE)

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIANT, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

z =                    RADIANT                (x)

### Example

pi =                    RADIANT                (180);

154

## RADIAT DIRECTIVE

The **RADIAT** directive is used in *data block* to add radiative exchanges between n walls linked to an **AXIAL** or a **THREED** element and impose related coefficients. These can't be modified during calculation. If used, this model replaces the standard radiative heat transfer correlations used in **CATHARE**.

The radiative exchanges can be desactivated at any time in the calculation using WRITE directive with RADSTAT CCV.

### **Associated Keywords**

WALL, AXIAL, THREED, WALL3D

## Syntax

```

RADIAT elem itypray
ALFAC alfac
WALLS n wall1 wall2 ...
EMISS emiss1 emiss2 ...
VIEWFAC F1,1 F1,2 ... F1,n
           F2,1 F2,2 ... F2,n
           ...
           Fn,1 Fn,2 ... Fn,n (n*n matrix)
BEAMLENG A1,2 A1,3 ... A1,n
           A2,3 ... A2,n
           ...
           ...
           An-1,n (n-1*n-1 matrix)
;
```

<b>elem</b>	: name of the pipe or 3D element.
<b>itypray</b>	: radiative mode :
<b>ABSORB</b>	: the fluid receives a part of the radiative power emitted by the walls.
<b>TRANSPA</b>	: the fluid does not receive any radiative power from the wall(s).
<b>ALFAC alfac</b>	: keyword followed by the minimal void fraction under which radiative heat transfer will not be computed by this model.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 484/851

**WALLS n** : keyword followed by the number (n) and the name of coupled walls.  
**wall1 ... walln**  
**EMISS emiss1 ...** : keyword followed by the emissivity of the n walls defined above. The emissivity is constant along the wall.  
**emissn**  
**VIEWFAC F1,1 ...** : keyword followed by the view factors.  
**Fn,n**  
**BEAMLENG A1,2 ... An-1,n** : keyword followed by the geometric beam length (m) used to compute the radiative power received by the fluid in case of ABSORB mode.

<b>Example</b>
----------------

```

S1 =      0.0794144 ;
S2 =      0.6289217 ;
F21 =     0.05 ;
F23 =     1.0          -          F21 ;
F12 = F21 *          S2 / S1 ;
F11 = 1.0  -          ( 2.0        *          F12 ) ;
a12 =     1.D-2 ;
a13 =     2.D-2 ;
a23 =     3.D-2 ;
RADIAT    AVCORE      ABSORB
ALFAC      0.9
WALLS      3 BOITIER   CHAR1      CHAR2
EMISS      0.9         0.9         0.9
VIEWFAC    F11         F12         F12
                  F21         0.0         F23
                  F21         F23         0.0
BEAMLENG  a12         a13
                  a23 ;
  
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 485/851

# 155

## REACTOR DIRECTIVE

The **REACTOR** directive is used just after the **RESTORE** command in *command block*. It allows **CATHARE** to load the reactor data (one circuit or the combination of all circuits connected or not with exchangers) before any computation.

### Associated Keywords

**RESTORE**, **TABLE**, **USE**

### Syntax

**REACTOR** reactname ;

**reactname** : Name of the reactor.

### Example

**RESTORE** ;  
**REACTOR** circtot ;

**NB** : The corresponding FORTRAN subroutine called in PILOT is REACTOR : CALL REACTOR (OBJNAM, LALIDENH, \*9999)

<b>OBJNAM</b> <b>LALIDENH</b> <b>*9999</b>	CHARACTER*8 reactor name INTEGER pointer on the head structure of the reactor (output). error treatment
--	---

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 486/851

# 156

## REACTOR OPERATOR

The **REACTOR** operator creates a reactor-type object, which is the same as the circuit if there is only one circuit in the data input deck, or the combination of all circuits connected or not with exchangers. Used in the *data block*.

### Associated Keywords

CIRCUIT, RADCHEMI, NONCOND, VALUE FOR A REACTOR, WRITE FOR A REACTOR

### Syntax

```
circtot =      REACTOR    circ1          ;  
or  
circtot=      REACTOR    circ1          ...           circn  
              (EXPLICIT) ;
```

<b>circtot</b>	: Name of the reactor.
<b>REACTOR</b> circ1	: Keyword followed by the list of the circuit names, which belong to the reactor.
...circn	
<b>EXPLICIT</b>	: OPTIONAL keyword available if n = 2 to enforce the coupling to be explicit between the circuits. (default coupling=implicit)

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 487/851

157

## READHCAT DIRECTIVE

The **READHCAT** directive, used in *command block*, reads the time, the time step and the hydraulic conditions needed for a step of a standalone fuel calculation.

This directive reads a file created by a previous **CATHARE** calculation where the hydraulics to be stored were chosen by the **STOREHYD** directive (see **CATAFUEL**, option 2).

In the following syntax, the variables *time* and *dt* are output values of the **READHCAT** directive. They will be used by the **STDYFUEL** or **TRANFUEL** directives.

### Associated Keywords

**CATAFUEL, STOREHYD, STDYFUEL, TRANFUEL**

### Syntax

**READHCAT**    cata                      time                      dt ;

<b>cata</b>	: Name of the catafuel element.
<b>time</b>	: real number $\geq 0$ . that is the time read in the fluid file and for which the preliminary hydraulic calculation has converged. The fuel standalone calculation must reach this time.
<b>dt</b>	: real number $> 0$ . representing the time step read in the fluid file and with which the preliminary hydraulic calculation has converged.

### Example

```
cata =                    CATAFUEL        hyd                      ;
...
END                      DATA                      ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 488/851

\*\*\*\*\* Reading of imposed hydraulic conditions, time and dt

```

...
REPEAT      BLOC1      NSTEP      ;
...
READHCAT    cata       time       dt       ;
TRANFUEL    cata       time       dt       ;
...
END         BLOC1      ;

```

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is READHCAT.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 489/851

158

## READHEAD DIRECTIVE

The **READHEAD** directive allows the user reading the heading in a personal opened file. It is used in the *command block*. It contains the date, the title of the input deck, the label of the version and a list of CUSER character variables (representing values indexes).

The format of the heading is as following :

<b>CDATE</b>	Date field
<b>CTITRE</b>	Title field
<b>CVERS</b>	@(#)_QLABEL.f_+_V25_3_+_4.198_09/17/04 NAME1 NAME4 NAME3 NAME2 NAME5

Where **CDATE**, **CTITRE**, **CVERS** are fixed keyword (used to reference the file).

The list of CUSER variables “NAMEi” are put in the CUSER common and can be retrieved using the VALUE operator.

**Warning :** the personal file can not be a **CATHARE** file.

### Associated Keywords

INTERP, OPENFILE, READVAR, REWIND, WRITHEAD, WRITVAR

### Syntax

```

READHEAD  nunite
              CUSER      SEGMENT    ideb ifin      ;
or
              LIST       i1          ...          in      ;

```

<b>nunite</b>	: user variable defined as an integer in the <i>command block</i> giving the Fortran unit number of the desired file (given by OPENFILE operator).
<b>CUSER</b>	: keyword to indicate that the table CUSER will be filled.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 490/851

**SEGMENT** : keyword followed by the integer values of the first and last CUSER indexes (limited to 10 in case of FORMATTED file).  
 ideb ifin  
 or  
**LIST** : keyword followed by the integer values of CUSER indexes (limited to 10 in case of FORMATTED file).  
 i<sub>1</sub> ... i<sub>n</sub>

### Example

```
READHEAD NUNITE1      CUSER
          SEGMENT      1           3 ;
READHEAD NUNITE2      CUSER
          LIST         1           3           5           6       ;
'PI' =     VALUE        CUSER      1 ;
```

**N.B** : the FORTRAN subroutine called in PILOT is READHEAD : CALL READHEAD ( NUNITE, MODLIST, NBLIST, IVAL, IVSTAT )

NUNITE	INTEGER : Fortran unit number
MODLIST	CHARACTER*8 : 'SEGMENT' or 'LIST'
NBLIST	INTEGER : number of CUSER indexes
IVAL	Array of INTEGER (NBLIST) : indexes of CUSER
IVSTAT	Returned error code

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 491/851

# 159

## READHEXT DIRECTIVE

The **READHEXT** directive, used in *command block*, reads the time, the time step and the hydraulic conditions needed for a step of a standalone fuel calculation.

This directive reads a file defined by the user (see **CATAFUEL**, option 1). The logical unit number of the hydraulic file must be specified in the **CATAFUEL** operator.

In the following syntax, the variables *time* and *dt* are output values of the **READHEXT** directive. They will be used by **STDYFUEL** and **TRANFUEL** directives.

### Associated Keywords

**CATAFUEL**, **STDYFUEL**, **TRANFUEL**

### Syntax

```
READHEXT cata           time           dt ;
```

<b>cata</b>	: name of the catafuel element.
<b>time</b>	: real number $\geq 0$ . that is the time to be reached by the fuel standalone calculation and that is read in the external fluid file.
<b>dt</b>	: real number $> 0$ . representing the time step read in the fluid file and corresponding to the fluid time.

### Example

```
cata =      CATAFUEL    hyd        FILE        81 ;
```

```
...  
END      DATA ;
```

```
***** Reading of imposed hydraulic conditions, time and dt in the file number 81
```

```
...
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 492/851

```

REPEAT      BLOC1      NSTEP ;
...
READHEXT   cata       time       dt ;
TRANFUEL   cata       time       dt ;
...
END        BLOC1 ;

```

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is READHEXT.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 493/851

# 160

## READMIX DIRECTIVE

### 160.1 Syntax of the READMIX directive

The **READMIX** directive is used in the *command block* to read an external file.

This directive has to be used with the **FLOMIXER ZOOM** option of **CATHARE2**.

The **READMIX** directive must precede the **STARTMIX** directive. The suffix of the external file must be named “.dat”.

#### Associated Keywords

**STARTMIX, FLOMIXER ZOOM, VOLUME**

#### Syntax

**READMIX mixname file\_name ;**

<b>mixname</b>	: <b>FLOMIXER ZOOM</b> name
<b>file_name</b>	: Name of the external file to be read. It must not exceed 4 characters with no ".dat" extension.

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is READMIX. The arguments are: CALL READMIX ( OBJDIR, CTYPE, 2, 1, 0, CVAL , IVAL , RVAL, \*9999)

<b>OBJDIR</b>	: array of character*8 words containing the name of the flomixer name
<b>CTYPE, CVAL</b>	: array of character*8 words containing any value (not used)
	: array of character*8 words containing the name of the external file (without .dat extension)
<b>IVAL</b>	: integer containing any value (not used)
<b>RVAL</b>	: real containing any value (not used)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 494/851

### Example

First, the **FLOMIXER ZOOM** object has to be defined in *the data block* (refer to the **FLOMIXER ZOOM** operator) and the external file to be read must be located in the current working directory. In the following example, the file name referenced in the data input deck is FIC1, and under the working directory, the file “FIC1.dat” provides the data for fluid mixing matrices.

```

MANTA =      FLOMIXER   ZOOM      1
              LOWRPLEN   LWPLEN
                               INLET
                               DOWNLWP1  DOWLWP2  DOWNLWP3
                               OUTLET    MIDLWP
                               LINKTO    BCCONDIT  ENTA
                               LINKTO    PIPE      CANA

              UPPRPLEN   UPPLLEN
                               INLET
                               OUTLET   CHAUDE1  CHAUDE2  CHAUDE3
                               CHAUDE1  MIDUPP
                               LINKTO    BCCONDIT  SORA
                               LINKTO    PIPE      CANA

              AGMAX     1.D-1
              DQMAX     1.D0
              FILENAME   FIC1      ;

```

Then, in *the exec block* the external file has to be read before starting the flow mix:

```

READMIX      MANTA      FIC1 ;
STARTMIX    MANTA ;

```

If the user wants to change the coefficients of distribution of the flow to mix, he can read any new file (FIC2.DAT) during the transient.

```

...
IF(        TIME      > EQ      10.D0
        .AND.      IFLAG      EQ      0)      THEN ;
IFLAG      = 1 ;
READMIX    MANTA      FIC2 ;
ENDIF ;

```

## 160.2 Format of the external file

The external file can be seen as “a set of data” governed by keywords. The purpose is to read the three distribution matrices needed for the FLOMIXER ZOOM application.

The first, (keyword QMATA) gives the distribution of flows entering the ZOOM core description.

The second, (keyword QMATB) gives the distribution of enthalpy flowrates entering the ZOOM core description.

This matrix gives also the distribution of the concentration flowrates in case of a computation with radio-chemical elements.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 495/851

The third (keyword QMATTR) gives the distribution of enthalpy flowrates entering the hot legs from the upper plenum. This matrix gives also the distribution of the concentration flowrates entering the hot legs from the upper plenum in case of a computation with radio-chemical elements.

#### FORMAT OF THE FILE

```
*0000 FORMAT(' @(#) fichnam.dat +_V25_3_+ new')
```

```
*****
```

```
* MATRICES DE DISTRIBUTION *
```

```
*****
```

```
*
```

```
NJMIMTOT nbrmel
```

```
*
```

```
*****
```

```
NJMIN num
```

```
*****
```

```
*
```

```
QMATA joncnam1
```

```
DIMENSION
```

```
nx ny
```

```
MATRICE
```

```
valq11 valq12 valq1nx
```

```
valq21 valq22 valq2nx
```

```
..etc..
```

```
valqny1 valqny2 valqnynx
```

```
*
```

```
QMATB joncnam1
```

```
DIMENSION
```

```
nx ny
```

```
MATRICE
```

```
valh11 valh12 valh1nx
```

```
valh21 valh22 valh2nx
```

```
..etc..
```

```
valhny1 valhny2 valhnynx
```

```
*
```

```
QMATTR joncnam2
```

```
DIMENSION
```

```
nx ny
```

```
MATRICE
```

```
valr11 valr12 valr1nx
```

```
valr21 valr22 valr2nx
```

```
..etc..
```

```
valrny1 valrny2 valrnynx
```

nbrmel num QMATA joncnam1 nx ny valq <sub>11</sub> ...         valq <sub>nxny</sub>	: Total number of mixture submodels : mixture number in the order entered in the input data deck under MANTA operator : keyword followed by the junction's name of the lower volume concerned by the mixture : number of loops concerned by the mixture submodel : number of axial elements concerned by the mixture submodel (lower plenum) : distribution coefficients for flowrates (lower plenum)
---	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 496/851

**QMATB joncnam1** : keyword followed by the junction's name of the lower volume concerned by the mixture submodel  
**valh<sub>11</sub> valh<sub>nxny</sub>** : distribution coefficients for enthalpy flowrates (lower plenum)  
**QMATR joncnam2** : keyword followed by the junction's name of the upper volume concerned by the mixture submodel  
**valr<sub>11</sub> valr<sub>nxny</sub>** : distribution coefficient for enthalpy flowrates (upper plenum)

### Example

```

*0000 FORMAT(' @(#) FIC1.dat +_V25_3_+ new')
*****
* MATRICE DE DISTRIBUTION DES DEBITS * (3 loop vessel)
*****
*
NJMIMTOT 2
*
*****
NJMIN 1
****« radial zoom on midcode with 6 channels »
*
QMATA MIDLWP
DIMENSION
3 6
MATRICE
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
*
QMATB MIDLWP
DIMENSION
3 6
MATRICE
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
0.167 0.167 0.167
*
QMATR MIDUPP
DIMENSION
3 6
MATRICE
0.334 0.334 0.334
0.334 0.334 0.334
0.334 0.334 0.334

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 497/851

0.334 0.334 0.334

0.334 0.334 0.334

0.334 0.334 0.334

\*

\*\*\*\*\*

NJMIN 2

\*\*\*\*\* « one single bypass / degenerated zoom bypass »

\*

QMATA BYPASLWP

DIMENSION

3 1

MATRICE

1. 1. 1.

\*

QMATB BYPASLWP

DIMENSION

3 1

MATRICE

1. 1. 1.

\*

QMATR BYPASUPP

DIMENSION

3 1

MATRICE

0.334 0.334 0.334

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 498/851

# 161

## READVAR DIRECTIVE

The **READVAR** directive allows the user reading variables in a personal opened file. It is used in the *command block*.

**Warning :** the personal file can not be a **CATHARE** file and be careful that the file does not contain any tabulation character.

**Remark :** a reactor's CCV is defined to determine if the end of the personal file is reached (READSTAT put to 1).

The variables are put in the XUSER common and can be got using the **VALUE FOR USER** operator.

### Associated Keywords

**INTERP, OPENFILE, READVAR, REWIND, WRITHEAD, WRITVAR, VALUE FOR USER, WRITE FOR USER**

### Syntax

<b>READVAR</b>	<b>nunite</b>	<b>INTERP</b> or <b>NOINTERP</b>	<b>LIN</b> <b>LOG</b>	<b>varref</b> <b>varref</b>
		<b>XUSER</b> or	<b>SEGMENT</b> <b>LIST</b>	ideb i <sub>1</sub> ... i <sub>n</sub> ifin ;

<b>nunite</b>	: user variable defined as an integer in the <i>command block</i> giving the Fortran unit number of the desired file (given by <b>OPENFILE</b> operator).
<b>INTERP</b>	: keyword indicating that the read value will be interpolated.
<b>LIN</b>	: keyword indicating that the read value will be linearly interpolated.
<b>or LOG</b>	: keyword indicating that the read value will be logarithmically interpolated.
<b>varref</b>	: searched value in abscissa column (first column) of the personal file.
<b>or</b>	
<b>NOINTERP</b>	: keyword indicating that the read value will not be interpolated.
<b>XUSER</b>	: keyword to indicate that the variable XUSER is going to be read.
<b>SEGMENT</b> ideb ifin	: keyword followed by the integer values of the first and last XUSER indexes (limited to 10 in case of FORMATTED file).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 499/851

or

**LIST i<sub>1</sub> ... i<sub>n</sub>** : keyword followed by the integer values of XUSER indexes (limited to 10 in case of FORMATTED file).

### Example

```

READVAR      NUNITE1      INTERP      LIN      15.D0
                XUSER        SEGMENT    1          3 ;
READVAR      NUNITE2      NOINTERP
                XUSER        LIST       1 3 5 6 ;
P =           VALUE        XUSER      1 ;

```

**N.B** : the FORTRAN subroutine called in PILOT is READVAR : CALL READVAR ( NUNITE, MODINT, RVAL, MODLIST, NBLIST, IVAL, IVSTAT)

NUNITE	INTEGER : Fortran unit number
MODINT	CHARACTER*3 : 'LIN' or 'LOG' or 'NO'
RVAL	DOUBLE PRECISION : target abscissa
MODLIST	CHARACTER*8 : 'SEGMENT' or 'LIST'
NBLIST	INTEGER : number of XUSER indexes
IVAL	Array of INTEGER (NBLIST) : XUSER indexes
IVSTAT	Returned error code

 <b>ce</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 500/851

# 162

## REALAX DIRECTIVE

The **REALAX** directive is used in the *command block* to impose the thermalhydraulic conditions (6 + number of non condensable values expected) in an axial element of a DEADZONE. It can be found after the **PERMITIT** operator or before the **REINIT** directive. The specified values are used to initialize (or reinitialize) the whole DEADZONE.

The axial element on which a constraint REALAX is applied must be the first element of the DEADZONE (see directive **PERMITIT**).

### Associated Keywords

**PERMITIT, REINIT, AXIAL, MONOPHAS(E)**

### Syntax

```

REALAX      pipej      ip1
P            p1
HL           hl1
or             TL        tl1
or             UNDERSAT  z1
or             HLSAT
or             UNDERSPV   z3
HV           hv1
or             TV        tv1
or             OVERHEAT   z2
or             HVSAT
or             OVERHEPV   z4
ALFA         al1
(X1)          x11)
(X2)          x12)
(X3)          x13)
(X4)          x14)
VL           vl1
VV           vg1
;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 501/851

<b>pipej</b>	: name of the axial element
<b>ip1</b>	: positive integer number that indicates the scalar point in the axial element, where the conditions are imposed.
<b>P p1</b>	: keyword followed by a real number (pressure in Pa)
<b>HL hl1</b>	: keyword followed by a real number (liquid enthalpy in J/kg)
<b>or TL tl1</b>	: keyword followed by a real number (liquid temperature in °C)
<b>or UNDERSAT z1</b>	: keyword followed by a real number ( $T_{sat}(P) - T_L$ , subcooling of water in °C)
<b>or UNDERSPV z3</b>	: keyword followed by a real number ( $T_{sat}(P_V) - T_L$ , subcooling of water in °C)
<b>or HLSAT</b>	: keyword used to impose the liquid enthalpy at saturation ( $T_{sat}(P) = T_L$ )
<b>HV hv1</b>	: keyword followed by a real number (gas enthalpy HG in J/kg)
<b>or TV tv1</b>	: keyword followed by a real number (gas temperature TG in °C)
<b>or OVERHEAT z2</b>	: keyword followed by a real number ( $T_V - T_{sat}(P)$ , overheating of the steam in °C)
<b>or OVERHEPV z4</b>	: keyword followed by a real number ( $T_V - T_{sat}(P_V)$ , overheating of the steam in °C)
<b>or HVSAT</b>	: keyword used to impose the steam enthalpy at saturation ( $T_V = T_{sat}(P)$ )
<b>ALFA al1</b>	: keyword followed by a real number (void fraction)
<b>XI xi1</b>	: OPTIONAL keyword followed by a real number (ith non condensable gas concentration)
<b>VL vl1</b>	: keyword followed by a real number (liquid velocity in m/s)
<b>VV vgl</b>	: keyword followed by a real number (gas velocity in m/s)

### Example

Assuming that DECHACC is an axial element belonging to a dead zone and the first one in the dead zone declaration (**PERMINIT**):

```
IPOINT =      SCALAR      dechacc      6.0      ;
REALAX      dechacc      IPOINT
            P          41.5D5
            HL         213.D3
            HVSAT
            ALFA        1.0D-5
            X1          1.0D-5
            VL          1.0D-8
            VV          1.0D-8 ;
```

Refer to **PERMINIT** operator for a global example of initialization

**NB :** The corresponding FORTRAN subroutine called in PILOT is REALAX. The argument are the following ones :  
 CALL REALAX ( OBJNAM, INODE, NINCON, CVAL, RVAL, NCVAL, NRVAL, \*9999 )

<b>OBJNAM</b>	: Name of the AXIAL element on which the conditions are imposed (character*8)
<b>INODE</b>	: number of the scalar node corresponding to the specified position (integer)
<b>NINCON</b>	: number of non-condensable gases in the calculation

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 502/851

CVAL	: array of all directive word arguments (character*8), i.e. in the example [dechacc, P, HL, HVSAT, ALFA, X1, VL, VV]
RVAL	: array of all values specified in the directive (double precision), i.e. in the example [41.5 · 10 <sup>5</sup> , 213 · 10 <sup>3</sup> , 10 <sup>-5</sup> , 10 <sup>-5</sup> , 10 <sup>-8</sup> , 10 <sup>-8</sup> ]
NCVAL	: length of array CVAL
NRVAL	: length of array RVAL

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 503/851

# 163

## REALC DIRECTIVE

The **REALC** directive is used after the **PERMINIT** directive, in the *command block*, to impose the (6+number of non-condensable gases) main variables on constraint junctions.

**Warning :** The maximum number of **REALC** which can be imposed for one circuit is calculated considering that all the elements declared within this circuit are linked. If the user defines several independent sub-circuits within one circuit, the maximum number of **REALC** calculated by **CATHARE** will not be representative of this case. In order to avoid this configuration the user should define one circuit for each independent sub-circuit.

### Associated Keywords

**PERMINIT**

### Syntax

<b>REALC</b>	junc1	<b>(GROUP)</b>
	<b>P</b>	p1
	<b>HL</b>	hl1
	or	<b>TL</b> tl1
	or	<b>UNDERSAT</b> z1
	or	<b>HLSAT</b>
	or	<b>UNDERSPV</b> z3
	<b>HV</b> hv1	
	or	<b>TV</b> tv1
	or	<b>OVERHEAT</b> z2
	or	<b>HVSAT</b>
	or	<b>OVERHEPV</b> z4
	<b>ALFA</b>	al1
	<b>(X1</b>	xl1)
	<b>(X2</b>	xl2)
	<b>(X3</b>	xl3)
	<b>(X4</b>	xl4)
	<b>VL</b>	vl1
	<b>VV</b>	vg1
	...	
	juncn	...
		;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 504/851

<b>junc1</b>	: name of the real constraint junction. .
<b>(...junen )</b>	If the junction is of type <b>GROUP</b> , it must be followed by the keyword <b>GROUP</b> . In that case, the main variables are imposed for all the junctions of the group.
<b>P p1</b>	: keyword followed by a real number (pressure expressed in Pa)
<b>HL hl1</b>	: keyword followed by a real number (liquid enthalpy expressed in J/kg)
<b>or</b>	
<b>TL tl1</b>	: keyword followed by a real number (liquid temperature expressed in °C)
<b>or</b>	
<b>UNDERSAT z1</b>	: keyword followed by a real number ( $T_{sat}(P) - T_L$ , temperature difference in °C)
<b>or</b>	
<b>HLSAT</b>	: keyword indicating that the liquid enthalpy at saturation is imposed ( $T_L = T_{sat}(P_V)$ )
<b>or</b>	
<b>UNDERSPV z3</b>	: keyword followed by a real number ( $T_{sat}(P_V) - T_L$ , temperature difference in °C)
<b>HV hv1</b>	: keyword followed by a real number (gas enthalpy HG expressed in J/kg)
<b>or</b>	
<b>TV tv1</b>	: keyword followed by a real number (gas temperature TG expressed in °C)
<b>or</b>	
<b>OVERHEAT z2</b>	: keyword followed by a real number ( $T_G - T_{sat}(P)$ ; temperature difference in °C)
<b>or</b>	
<b>HVSAT</b>	: keyword indicating that steam enthalpy at saturation is imposed ( $T_G = T_{sat}(P_V)$ )
<b>or</b>	
<b>OVERHEPV z4</b>	: keyword followed by a real number ( $T_G - T_{sat}(P_V)$ , temperature difference in °C)
<b>ALFA al1</b>	: keyword followed by a real number (void fraction)
<b>XI xli</b>	: OPTIONAL keyword followed by a real number ( $i^{th}$ non condensable gas concentration; i=1 to 4)
<b>VL vl1</b>	: keyword followed by a real number (liquid velocity expressed in m/s)
<b>VV vg1</b>	: keyword followed by a real number (steam velocity expressed in m/s)

### Example

Assuming that DOWNFOND and GUIDCOUV are standard junctions and BOTA a junction of type **GROUP**:

<b>REALC</b>	<b>downfond</b>	<b>P</b>	161.330D5
		<b>HL</b>	1293.33D3
		<b>HVSAT</b>	
		<b>ALFA</b>	1.D-5
		<b>X1</b>	1.D-5
		<b>VL</b>	8.021D0
		<b>VV</b>	8.021D0
	<b>guidcouv</b>	<b>P</b>	157.587D5
		<b>HL</b>	1293.31D3
		<b>HVSAT</b>	
		<b>ALFA</b>	1.D-5
		<b>X1</b>	1.D-5
		<b>VL</b>	0.5D0
		<b>VV</b>	0.5D0 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 505/851

<b>REALC</b>	bota	<b>GROUP</b>
	P	161.330D5
	HL	1293.33D3
	HVSAT	
	ALFA	1.D-5
	X1	1.D-5
	VL	8.021D0
	VV	8.021D0 ;

Refer to **PERMINIT** operator for a global example of initialization.

**NB :** The corresponding FORTRAN subroutine called in PILOT is REALC. The arguments are the following ones: CALL REALC ( CVAL, RVAL, NVAL, NINCON, \*9999)

CVAL	CHARACTER*8 array of directive word arguments ( i.e. in the example [downfond, P, HL, HVSAT, ALFA, X1, VL, VV])
RVAL	DOUBLE PRECISION array of values specified in the directive (i.e. in the example, [161.330 · 10 <sup>5</sup> , 1293.33 · 10 <sup>3</sup> , 10 <sup>-5</sup> , 10 <sup>-5</sup> , 8.021, 8.021]
NVAL	INTEGER length of arrays CVAL and RVAL
NINCON	INTEGER number of non-condensable gases

DE LA RECHERCHE À L'INDUSTRIE <b>cea</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 506/851

# 164

## REALLIST OPERATOR

The **REALLIST** operator, used in the *data block*, creates a list object using an arbitrary number (<100) of **INTEGER** or **REAL** numbers. This operator can be used to define Boundary Condition as BC3A, BC3B, BC3C, BC3D, BC3E, BC3F, BC3G, BC3H, BC5XX and BC5YY (**MODEL**).

In other boundary conditions as BC4A, BC4B, BC5A, **REALLIST** is only a keyword followed by a list of real or integer numbers, which cannot create an object.

REALLIST object is also used in **WALL** operator to give the volumetric power or the exchange coefficient and outside temperature or the flux.

In the command block, **REALLIST** operator cannot be used. The **keyword** **REALLIST** is used in the **BCMOD** (or **POWER**, or **PUMPMOD**, ...) directive just before a list of real or integer numbers.

### Associated Keywords

**MODEL**

### Syntax

```
pp=      REALLIST    z1          z2...          zj          ;
```

<b>pp</b>	: name of the initial object
<b>zj</b>	: integer or real number

### Example

```
VL0=      0.1D0 ;
VV0=      0.1D0 ;
VL1=      1.000D0 ;
VV1=      1.000D0 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 507/851

VL2 = 1.000D0 ;  
VV2 = 1.000D0 ;  
VL3 = 1.000D0 ;  
VV3 = 1.000D0 ;

VLLIST = REALLIST  
VL0 VL1 VL2 VL3 ;

VVLIST = REALLIST  
VV0 VV1 VV2 VV3 ;

<b>DE LA RECHERCHE À L'INDUSTRIE</b> 		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 508/851

# 165

## REALVO DIRECTIVE

The **REALVO** directive is used after the **PERMITIT** or before the **REINIT** operator, in the *command block*, to impose the thermalhydraulic conditions in a volume element of a DEADZONE. The specified values are used, by the steady state calculation, to initialize the whole DEADZONE. The volume element on which a constraint REALVO is applied must be declared as the first element of the DEADZONE (see directive **PERMITIT**). **LEVEL**directive can also be used to initialize the level in the volume element.

### Associated Keywords

**PERMITIT, REINIT, LEVEL, VOLUME**

### Syntax

<b>REALVO</b>	volumj
<b>LIQUID</b>	
<b>HL</b>	hl1
or	<b>TL</b> tl1
or	<b>UNDERSAT</b> z1
or	<b>HLSAT</b>
or	<b>UNDERSPV</b> z3
<b>HV</b>	hv1
or	<b>TV</b> tv1
or	<b>OVERHEAT</b> z2
or	<b>HVSAT</b>
or	<b>OVERHEPV</b> z4
<b>ALFA</b> al1	
( <b>X1</b> )	x11)
( <b>X2</b> )	x12)
( <b>X3</b> )	x13)
( <b>X4</b> )	x14)
<b>GAS</b>	
<b>P</b>	p1
<b>HL</b>	hl1
or	<b>TL</b> tl1
or	<b>UNDERSAT</b> z1
or	<b>HLSAT</b>
or	<b>UNDERSPV</b> z3

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 509/851

**HV** hv1  
 or **TV** tv1  
 or **OVERHEAT** z2  
 or **HVSAT**  
 or **OVERHEPV** z4  
**ALFA** al1  
**(X1** x11)  
**(X2** x12)  
**(X3** x13)  
**(X4** x14);

**volumj** : name of the volume element  
**LIQUID** : keyword that indicates the lower sub-volume conditions will follow  
**HL h1** : keyword followed by a real number (liquid enthalpy expressed in J/kg)  
 or  
**TL tl1** : keyword followed by a real number (liquid temperature expressed in °C)  
 or  
**UNDERSAT z1** : keyword followed by a real number ( $T_{sat}(P) - T_L$ , temperature difference in °C)  
 or  
**HLSAT** : keyword indicating that the liquid enthalpy at saturation is imposed ( $T_L = T_{sat}(P_V)$ )  
 or  
**UNDERSPV z3** : keyword followed by a real number ( $T_{sat}(P_V) - T_L$ , temperature difference in °C)  
  
**HV hv1** : keyword followed by a real number (gas enthalpy HG expressed in J/kg)  
 or  
**TV tv1** : keyword followed by a real number (gas temperature TG expressed in °C)  
 or  
**OVERHEAT z2** : keyword followed by a real number ( $T_G - T_{sat}(P)$ , temperature difference in °C)  
 or  
**HVSAT** : keyword indicating that steam enthalpy at saturation is imposed ( $T_G = T_{sat}(P_V)$ )  
 or  
**OVERHEPV z4** : keyword followed by a real number ( $T_G - T_{sat}(P_V)$ , temperature difference in °C)  
  
**ALFA al1** : keyword followed by a real number (void fraction)  
**XI xli** : OPTIONAL keyword followed by a real number ( $i^{th}$  non condensable gas concentration; i=1 to 4)  
**GAS** : keyword that indicates the upper sub-volume conditions will follow  
**P p1** : keyword followed by a real number (upper sub-volume pressure in Pa)  
**HL h1** : keyword followed by a real number (liquid enthalpy expressed in J/kg)  
 or  
**TL tl1** : keyword followed by a real number (liquid temperature expressed in °C)  
 or  
**UNDERSAT z1** : keyword followed by a real number ( $T_{sat}(P) - T_L$ , temperature difference in °C)  
 or  
**HLSAT** : keyword indicating that the liquid enthalpy at saturation is imposed ( $T_L = T_{sat}(P_V)$ )  
 or  
**UNDERSPV z3** : keyword followed by a real number ( $T_{sat}(P_V) - T_L$ , temperature difference in °C)  
  
**HV hv1** : keyword followed by a real number (gas enthalpy HG expressed in J/kg)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 510/851

or

**TV tv1** : keyword followed by a real number (gas temperature TG expressed in °C)

or

**OVERHEAT z2** : keyword followed by a real number ( $T_G - T_{sat}(P)$ , temperature difference in °C)

or

**HVSAT** : keyword indicating that steam enthalpy at saturation is imposed ( $T_G = T_{sat}(P_V)$ )

or

**OVERHEPV z4** : keyword followed by a real number ( $T_G - T_{sat}(P_V)$ , temperature difference in °C))

**ALFA al1** : keyword followed by a real number (void fraction)

**XI xli** : OPTIONAL keyword followed by a real number ( $i^{th}$  non condensable gas concentration; i=1 to 4)

### Example

Assuming that VOLACCU is a volume element, first declared, of a dead zone:

REALVO	volaccu			
	LIQUID	TL	50.0	
		TV	51.	
		X1	0.	
	GAS	P	41.5D5	
		HL	213.D3	
		HVSAT		
		X1	0.998 ;	

Refer to **PERMINIT** operator for a global example of initialization.

**NB** : The corresponding FORTRAN subroutine called in PILOT is REALVO. The argument are the following ones:  
**CALL REALVO ( OBJNAM, CVAL, RVAL, NCVAL, NRVAL, NINCON, \*9999 )**

OBJNAM	: Name of the VOLUME element on which the conditions are imposed (character*8)
CVAL	: array of all directive word arguments (character*8), i.e. in the example [volaccu, TL, TV, X1, P, HL, HVSAT, X1])
RVAL	: array of all values specified in the directive (double precision), i.e. in the example, [50, 51, 0, $41.5 \cdot 10^5$ , $213 \cdot 10^3$ , 0.998]
NCVAL	: length of array CVAL
NRVAL	: length of array RVAL
NINCON	: number of non-condensable gases in the calculation

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 511/851</a>

# 166

## REFLCH3D OPERATOR

The **REFLCH3D** operator, used in the *data block*, defines the reflooding characteristics of a **WALL** or a **FUELCHAR** of a **THREED** element. The use of this operator and the syntax is exactly the same as the **REFLCHAR** operator used for axial element (see **REFLCHAR**).

### Associated Keywords

**REFLOOD, REFLCHAR, FUELCHAR, WALL3D, THREED, VALUE FOR REFLCHAR, WRITE FOR REFLCHAR**

### Syntax

<b>refchar1=</b>	<b>REFLCH3D</b>	<b>wall</b>				
	<b>QUEENCH</b>	<b>BOTTOM</b>	(or	<b>TOP)</b>		
	<b>IQF</b>	<b>iqf</b>				
	<b>INMI</b>	<b>inm1</b>	<b>inm2</b>	...	<b>inmj</b>	
	<b>DZPPS</b>	<b>dzp1</b>	<b>dzp2</b>	...	<b>dzpn</b>	
	<b>DXMAX</b>	<b>dxmax</b>	<b>DTMXPS</b>	<b>dtmxps</b>	<b>QFV</b>	<b>qfv</b>
	( <b>POINTT</b>	<b>zqf0</b> ) ;				

<b>refchar1</b>	: name of the reflch3d object
<b>wall</b>	: name of a fuelchar element (defined from an assembly of FUEL3D elements) or a WALL3D element (no EXCHANGER wall is allowed). The wall or fuelchar must belong to a vertical column of the 3D hydraulic meshing. The main fluid flow must be oriented along vertical axis.

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 512/851

167

## REFLCHAR OPERATOR

The **REFLCHAR** operator, used in the *data block*, defines the reflooding characteristics of a **WALL**, or **FUELCHAR** of an **AXIAL** element. The reflooding computation itself is not carried out until the **REFLOOD** directive is used in the command block.

### Associated Keywords

**REFLOOD, FUELCHAR, WALL, AXIAL, VALUE FOR REFLCHAR, WRITE FOR REFLCHAR**

### Syntax

refchar1=	<b>REFLCHAR</b>	wall				
	<b>QUENCH</b>	<b>BOTTOM</b>	(or	<b>TOP)</b>		
	<b>IQF</b>	iqf				
	<b>INMI</b>	inm1	inm2	...	inmj	
	<b>DZPPS</b>	dzp1	dzp2	...	dzpn	
	<b>DXMAX</b>	dxmax	<b>DTMXPS</b>	dtmxps	<b>QFV</b>	qfv
	( <b>POINTT</b>	zqf0 ) ;				

**wall** : wall or fuel on which the reflooding characteristics are to be defined. The wall or the fuel must belong to an axial element. The hydraulic flow in this element must be vertical. The reflooding characteristics must not be defined on an exchanger.

**QUENCH** : keyword indicating that the type of reflooding has to be entered.

**BOTTOM or TOP** : keyword to choose either a Bottom-Up reflooding (BOTTOM) or a Top-Down reflooding (TOP).

The start-up of a 2D Bottom-Up quench front is automatically done by the code (1D reflooding module).

For a Top-Down quench front, the value of POINTT allows to choose the initial position of the quench front on the pipe and the user has to check the local thermalhydraulic conditions: the downstream mesh wet wall temperature must be above ( $T_{sat} + 100^\circ C$ ) ; the upstream mesh must have a wet wall temperature less than ( $T_{sat} + 40^\circ C$ ) and a void fraction less than 0.995.

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 513/851</a>

**IQF iqf** : keyword followed by an integer  $> 0$  giving the number of the point where the quench front is located in the two-dimensional mesh used by the reflooding computation module.

**INMI inm1 inm2 ...inmn** : keyword followed by a list of **n** integers  $> 0$  giving the number of radial meshes per medium (**n** = number of media) of the two-dimensional mesh:

- for a wall there are as many media as there are materials.
- for a fuel there are a total of 5 media (**UO<sub>2</sub>**, gap, internal oxide, cladding, external oxide). Except for **UO<sub>2</sub>**, the number of meshes per media is fixed : 1 for gap , internal and external oxide and 3 for cladding.

**DZPPS dzp1 dzp2 ...dzpm** : keyword followed by a list of **m** real numbers  $> 0$ . giving the value of the axial steps dzpi of the two-dimensional mesh.

**Warning :  $m \geq 2 \times iqf$**

- the meshing must be continued at least as far as the quench front elevation in the 2D meshing).
- the meshing should be symmetric with respect to IQF (advice).
- the total axial length of the 2D conduction meshing must be of the same magnitude as an axial hydraulic mesh.

**DXMAX dxmax** : keyword followed by a real number  $> 0$ . (mandatory but unused)

**DTMXPS dtmxps** : keyword followed by a real number  $> 0$ . (mandatory but unused)

**QFV qfv** : keyword followed by a real number  $> 0$ . (mandatory but unused)

**POINTT zqf0** : OPTIONAL keyword (allowed only for top-down reflooding). It is followed by a real number  $> 0$ . defining the initial position of the quench front (m) (relative to the bottom of the wall). By default the quench front starts at the top of the wall.

<b>Example</b>
----------------

```

refchar1 =
      REFLCHAR    wall1
      QUENCH      BOTTOM
      IQF         8
      INMI        3 1 1 3 1
      DZPPS       0.025      0.01      0.004      0.001
                  0.2D-3     0.1D-3     0.4D-4     0.1D-3
                  0.5D-3     0.5D-3     0.5D-3     0.5D-3
                  0.1D-2     0.1D-2     0.1D-2     0.1D-2
                  0.1D-2     0.5D-2     0.5D-2     0.5D-2
                  0.5D-2
      DXMAX       0.05
      DTMXPS      2.0
      QFV         0.02 ;
  
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 514/851

# 168

## REFLOOD DIRECTIVE

The **REFLOOD** directive, in the command block, is used to begin a reflooding computation on a **WALL**, **WALL3D** or **FUELCHAR** of a given element, using the reflooding characteristics defined in **REFLCHAR** or **REFLCH3D** operator.

The computation is started as soon as the directive is called.

This directive can only be used once on each **REFLCHAR** or **REFLCH3D** element and only as part of a transient calculation.

### N.B. :

1. In 1D module (**AXIAL**) or a vertical column of 3D module, two reflooding modules can run only if they are of 2 different types (BOTTOM and TOP). (A maximum of 2 REFLCHAR objects can be used).
2. One pair (BOTTOM, TOP) of reflooding modules can be run independently on each fuelchar or wall element of an hydraulic 3D module.
3. Bottom-Top reflooding is automatically managed by **CATHARE**.
4. Top-Down reflooding has to be started under adequate conditions, i.e.:
  - (a) temperature of the wet wall just downstream of the quench front must be greater than  $T_{sat}(P) + 100^\circ C$ ;
  - (b) void fraction upstream of the quench front must be less than 0.995 ;
  - (c) temperature of the wet wall upstream of the quench front must be less than  $T_{sat}(P) + 40^\circ C$  in order to be considered to have been reflooded.

### Associated Keywords

**REFLCHAR**, **REFLCH3D**

### Syntax

**REFLOOD**      **refchar1** ;

**refchar1**            : reflchar or reflch3d object on which the reflooding computation is to be run.

**NB** : the corresponding FORTRAN subroutine called in PILOT is RENOY : CALL RENOY (OBJNAM, \*9999)

**OBJNAM**            : name of the reflchar or reflch3d object (character\*8);

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 515/851

# 169

## REINIT DIRECTIVE

The **REINIT** directive of the *command block* allows the user to reinitialize a DEADZONE (see directive **PERMINIT**). It must be used after directives **REALAX** and/or **REALVO** in order to impose new thermalhydraulic conditions. It can be used at any time of the transient. In such a case, energy and mass balances should be reinitialized using **INIBIL** directive  
**Warning :** **REALAX** and **REALVO** directives have to be used exactly at the same points as those which where used for **PERMINIT** directive

### Associated Keywords

**REALVO, REALAX**

### Syntax

```
REINIT      circ1          zone1          ;
```

**circ1** : name of the circuit to which the zone belongs.  
**zone1** : name of the DEADZONE to reinitialize. This zone must have been defined in directive **PERMINIT**.

### Example

Assuming ZONEAC1 ans ZONEAC2 are dead zones of the circuit CIRC1.

```
REINIT circ1  zoneac1 ;  
REINIT circ1  zoneac2 ;
```

**N.B :** the FORTRAN subroutine called in PILOT is REINIT. The argument are the following : CALL REINIT ( OBJNAM, CZONE, \*9999)

**OBJNAM** : name of the circuit (character\*8).  
**CZONE** : name of the zone to be reinitialized (character\*8).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 516/851

170

## RELOC DIRECTIVE

The **RELOC** directive enables the fuel relocation model after cladding burst. This operator must be used in executable block. The parameters of this directive are :

- The name of the fuel rod to which the directive is applied (valid for every rod type : standard or copernic),
- The size of fuel fragments used to calculate the residual gap,
- The size of fuel fragments used to calculate the equivalent thermal conductivity,
- The volume fraction of balloon filled by fuel after relocation. This argument is optional and its default value is 0.53.

### Associated Keywords

**FUELCHAR, RUPTURE**

### Syntax

```
RELOC elem d_gap d_cond (volume_fraction) ;
```

**elem** : name of the FUELCHAR element for which the model is going to be activated.

**d\_gap** : diameter of fuel fragments used to calculate the gap size (Type: double; unit: m).

**d\_cond** : diameter of fuel fragments used to calculate the thermal conductivity (Type: double; unit: m).

**volume\_fraction** : OPTIONAL  
Volume fraction of balloon filled by fuel after relocation (Type: double).  
Default value is 0.53D0.

**N.B** :This directive impacts directly the **CATHARE** calculation.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 517/851

<b>Example</b>
----------------

RELOC	CRAY01RR	0.002	0.002	0.5
RELOC	CRAY01RR	0.002	0.001	

**N.B :** The corresponding FORTRAN subroutine called in PILOT is RELOC :  
CALL RELOC (OBJNAM, d\_gap, d\_cond, volume\_fraction)

OBJNAM	CHARACTER*8 name of the FUELCHAR for which the model is going to be activated.
--------	--

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 518/851

171

## REPEAT DIRECTIVE

This directive is used to perform a loop around a set of instructions. Used in the *command block*.

### Associated Keywords

**END, IF, ENDIF, ELSE, QUIT, AND, OR**

### Syntax

**REPEAT**      blockj      n      ;

**blockj**                    : name of a block of instructions.  
**n**                            : integer to indicate how many times the block is to be repeated.

**N.B:** A line using **REPEAT** or **END** directives should not carry any other instruction

**Warning:** In the present version the word NSTEP is a keyword used in the PERIOD directive , so it cannot be used in the REPEAT directive . The following syntax would lead to an error :

```
NSTEP =      1000 ;
REPEAT      BLOC1      NSTEP      ;
```

### Example

```
i =      2 ;
REPEAT      BOW      4 ;
            i =      i**2;
END      BOW ;
NSTEPS =    500 ;
TMAX =     100. ;
REPEAT      BLOC1      NSTEPS ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 519/851

```

TIME =      TIME      + DT ;
TRANSIENT   c1       TIME      DT ;
IF (        TIME      >        TMAX) ;
                  QUIT      BLOC1 ;
ENDIF ;
BLOC1 ;
END

```

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 520/851

172

## RESETIME DIRECTIVE

The **RESETIME** directive allows the user to change the simulated time in a reactor. It may be useful after a steady state obtained by stabilized transient with control command. Used in the *command block*.

### Associated Keywords

**REACTOR, RESTORE**

### Syntax

**RESETIME**    reactor              time;

**reactor**                         : reactor name.  
**time**                                : compulsory real number equal to 0.

The time is reset to 0. in each circuit, the iteration number is set to 0, the time step value is put to  $10^{-5}$ s.

**Warning :** RESETIME must only be used in case of a restart and just after the **RESTORE** and **REACTOR** directives. Control commands have to be stopped (do not forget **OPTION REGUL OFF** if using this facility) before this directive. All laws depending on time will be affected.

Any result (in FORT21 file) that may have been saved before is lost.

### Example

```
RESTORE    n ;
REACTOR   ciretot ;
RESETIME  ciretot      0.D0 ;
RESULT     ciretot      NSTEP      10 ;
DT =       NEWDT ;
TIME =    NEWTIME ;
```

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 521/851

**N.B.** : the FORTRAN subroutine called in PILOT is RSETIM : CALL RSETIM (OBJNAM, NEWT, \*9999).

OBJNAM	CHARACTER*8 reactor name
NEWT	DOUBLE PRECISION reset time value (0.D0)

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 522/851

173

## RESHCAT DIRECTIVE

The **RESHCAT** directive is used to modify writing frequency of **CATHARE** variables in hydraulic file FORT62 (BINARY) / FORT63 (FORMATTED) necessary for the standalone fuel calculation. Used in the *command block*.

The **RESHCAT** directive can be used several times for a same reactor during a calculation.

The aim of this directive is to decrease the size of the fluid file used by the standalone fuel module. It must be used carefully, so that not to lose important information during a transient (ex. When the critical heat flux is reached). Its syntax is the same as that of the **RESULT** directive.

### Associated Keywords

**STOREHYD**, **HYDCHAN**, **CATAFUEL**, **CATAFUEL**

### Syntax

<b>RESHCAT</b>	<b>reacnam</b> or	<b>SECOND</b>	s	
		<b>NSTEP</b>	n	;

<b>reacnam</b>	: name of a reactor.
<b>SECOND s</b>	: keyword followed by a real number $\geq 0$ . : result storage period (s).
<b>NSTEP n</b>	: keyword followed by an integer $\geq 0$ : storage period expressed in terms of number of time steps. (default value = 1)

### Examples

RESHCAT	circtot	SECOND	0.5 ;
RESHCAT	circtot	NSTEP	10 ;

#### **N.B:**

1. **RESHCAT** directive have to be used in the command block, only if **STOREHYD** directive has been defined in the data block. (see operator CATAFUEL, option 2).
2. the FORTRAN subroutine called in PILOT is **RESHCAT**.

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
		<b>Document technique DEN</b>

Page 523/851

# 174

## RESTEST DIRECTIVE

The **RESTEST** directive is designed to test the **SAVE/RESTORE** functionality of **CATHARE**.

It must be used after a first calculation where several savings have been performed by **SAVE** directive. Once the first calculation is finished the user must copy the file *V25\_3.RESTART* into the new file *V25\_3.RESTEST*. Then, in a restart calculation using **RESTORE** directive, each saving can be tested by directive **RESTEST** which must be defined at same times as the savings of the first calculation. The **RESTEST** directive reads, in file *V25\_3.RESTEST*, the values that have been saved and compare them to the values stored in memory. If differences appear, it means that the **SAVE/RESTORE** functionality is corrupted<sup>1</sup> and the restart calculation is stopped. The **RESTEST** directive must be used in *the command block*.

In case such a problem appears please contact the **CATHARE** Maintenance Team.

**Warning:** This directive is not available on all computers.

### Associated Keywords

**SAVE, RESTORE**

### Syntax

**RESTEST n ;**

### Example

#### **Input data file for first calculation**

```
...
ISAVE =      0 ;
TSAVE =     10.0D0 ;
SAVE      1 ;
...
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 524/851

```

REPEAT      BLOC1      NSTEP1
TIME =      TIME       + DT ;
IF (        TIME       >          TSAVE ) ;
            ISAVE      + 1 ;
            TSAVE      + 10.0D0 ;
            SAVE       ISAVE ;
ENDIF ;
TRANSIENT   CIRC1      TIME       DT ;
TIME =      NEWTIME ;
DT =        NEWDT ;
END         BLOC1 ;
...
...
ISAVE =      0 ;
TSAVE =      10.0D0 ;
RESTORE     1 ;
...
REPEAT      BLOC1      NSTEP1
TIME =      TIME       + DT ;
IF          (TIME      >          TSAVE ) ;
            ISAVE      + 1 ;
            TSAVE      + 10.0D0 ;
            RESTEST    ISAVE ;
ENDIF ;
TRANSIENT   CIRC1      TIME       DT ;
TIME =      NEWTIME ;
DT =        NEWDT ;
END         BLOC1 ;
...

```

**N.B :** the FORTRAN subroutine called in PILOT is RESTEST : CALL RESTEST ( NLABELL, \*9999)

NLABELL INTEGER number of the back-up label.  
\*9999 fatal error treatment.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 525/851

175

## RESTORE DIRECTIVE

### 175.1 Restore after the pre-processing READER treatment

The **RESTORE** directive which is used to restore reactor data issued from a READER execution has no label number. The data are read from the file V25\_3.INIT. Used in the *command block*.

#### Example

RESTORE ;      to read      V25\_3.INIT

### 175.2 Restore after the kernel CATHARE computation

The **RESTORE** directive, followed by a label number  $0 < n < 999$  is used to restore the reactor state issued from a previous **CATHARE** computation ; the reactor state saved at time “SAVE n” directive was used. The state data are read from the file V25\_3.RESTART. Used in the *command block*.

If the directive **INISIM** has been used, a COMMON is used instead of the file (used only for simulator applications).

#### Associated Keywords

SAVE, RESTEST, REACTOR, TABLE, USE

#### Syntax

<b>RESTORE</b>	<b>n</b>	
	or	(DUMP)
	or	(DUMPOONLY)
	or	(DUMPCHECK)

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 526/851

<b>n</b> <b>DUMP</b> <b>DUMPOONLY</b> <b>DUMPCHEK</b>	<p>: integer &gt; 0 and &lt; 999 which must be used to restore the reactor state issued from the previous computation corresponding to this label.</p> <p>: OPTIONAL keyword indicating to the code that the FAST.H has to be read from the V25_3.RESTART file. The standard restart is replaced by this one. The restart is binary identical to the calculation without restart.</p> <p>: OPTIONAL keyword indicating to the code that the FAST.H has to be read from the V25_3.DUMP_FAST.BIN file. The standard restart with the V25_3.RESTART is also possible. Use only once. The restart is binary identical to the calculation without restart.</p> <p>: OPTIONAL keyword indicating to the code, after reading the V25_3.DUMP_FAST.BIN file, to compare the FAST.H file to the V25_3.RESTART. This option requires on the one hand, a standard restart ("RESTORE N-1") before use and on the other hand a dump restart file and to put the IODEBUG variable to 1 in the PRECAT.f subroutine. This directive produce the V25_3.DUMP_CHK.TXT file which give all differences between the standard RESTORE and the RESTORE DUMP (give the name and the label of the concerned pointer).</p> <p><b>Warning:</b> As it is not pertinent for variables that are neither stored nor computed at each time steps like permitt variables (computed once during the permitt phases) a work arrays for initialization, this option should be better used one time step after the standard restart to get read of warning about work variables, work arrays. Warning about permitt and initialization variables will still be displayed.</p>
--	---

### Example

To read the state saved with the label number 1 in file V25\_3.RESTART  
 RESTORE 1 ;

**For more examples of the use of the **SAVE** and **RESTORE** directives see the **Users Manual**.**

**NB1:** Label 999 is assigned to a special reactor state activated automatically by **CATHARE** after an incident during computation ( error, no convergence, ... ). It contains the state of the reactor computation just before the incident.  
**N.B2 :** the FORTRAN subroutine called in PILOT is RESTOR : CALL RESTOR ( NLABELL, \*9999).

NLABELL                    INTEGER number of the back-up label.  
 \*9999                    fatal error treatment.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 527/851

## 175.3 Restore after the CATHARE computation with a new input data deck

This specific use of the directive **RESTORE** allows to restore the reactor state issued from a previous **CATHARE** computation and to continue a calculation with data issued of another block data in a new file V25\_3.INIT. This directive is used in the *command block*.

### Associated Keywords

**SAVE, RESTEST, REACTOR**

### Syntax

```
RESTORE    NEW DATA    ndata
           RESTART     FILE      nlabel ;
```

<b>NEW DATA</b>	: keyword indicating that the computation will be done with a new input data deck.
<b>ndata</b>	: integer > 0 corresponding to the label in a new file V25_3.INIT.
<b>RESTART FILE</b>	: keyword indicating that the computation will be done from a restart file.
<b>nlabel</b>	: 0<integer <999 corresponding to the label in the file V25_3.RESTART from which the computation will be restarted.

**Warning:** the restore with a new input data deck is not compatible with DUMP options.

### Example

An example describing the linking of directives **SAVE**, **USE** and **RESTORE** is given in the **USE** directive chapter.

**NB1:** Label 999 is assigned to a special reactor state activated automatically by **CATHARE** after an incident during computation ( error, no convergence, ... ). It contains the state of the reactor computation just before the incident.

**N.B2 :** the FORTRAN subroutine called in PILOT is RESTOPN : CALL RESTOPN ( NDATA, NLABELL, \*9999).

<b>NDATA</b>	INTEGER number of the back-up label of the data file (V25_3.INIT).
<b>NLABELL</b>	INTEGER number of the back-up label of the restart file (V25_3.RESTART).
<b>*9999</b>	fatal error treatment.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 528/851

176

## RESULT DIRECTIVE

The **RESULT** directive is used to initialize or modify writing frequency of results on the results file FORT21[1]. Used in the *command block*.

The **RESULT** directive can be used several times for the same element during a calculation.

### Associated Keywords

PERIOD, LIST, IMPRIME, MESSAGE, PRIN3D, TITLE, RESETIME

### Syntax

<b>RESULT</b>	<b>elem</b>	<b>(GROUP)</b>	<b>SECOND</b>	<b>s</b>	
					or
			<b>NSTEP</b>	<b>n</b>	;

<b>elem</b>	: name of a reactor, a circuit, a catafuel or an hydraulic element. If the hydraulic element (axial or bcondit) is of type <b>GROUP</b> , it must be followed by the keyword <b>GROUP</b> . In that case, all the elements of the group are written in the result file FORT21.
<b>SECOND s</b>	: keyword followed by a real number $\geq 0$ . : result storage period (s).
<b>NSTEP n</b>	: keyword followed by an integer $\geq 0$ : storage period expressed in terms of number of time steps.

**Warning :** When the keyword **NSTEP** is used, the **RESULT** directive must be placed after **GOPERM** directive in the input deck.

### Examples

```
RESULT    circtot     SECOND    0.5 ;
RESULT    circ1       SECOND    0.1 ;
RESULT    cata1       NSTEP     10 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 529/851

RESULT grapp NSTEP 5 ;  
 RESULT cana **GROUP** NSTEP 5 ;

In the last example, we assume that cana is an **AXIAL GROUP** element.

**N.B:**

1. User variables have the same storage frequency as the REACTOR.
2. The result storage period should be greater for circuit (or element) than for reactor.

**Advice:** Use always RESULT for reduce the storage frequency.

**N.B :** the FORTRAN subroutine called in PILOT is RESULT: CALL RESULT (ITYP,NPERIO,TPERIO,CCC, \*9999).

ITYP	INTEGER value : 1 if NSTEP, 2 if SECOND.
NPERIO	INTEGER value for storage period (ITYP=1).
TPERIO	DOUBLE PRECISION value for storage period (ITYP=2).
CCC	CHARACTER*8 object name.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 530/851

**177**

## **REWIND DIRECTIVE**

The **REWIND** directive allows the user coming back to the beginning of a personal file (formatted or not). It is used in the *command block*.

**Warning :** the personal file can not be a **CATHARE** file.

### **Associated Keywords**

**INTERP, OPENFILE, READHEAD, READVAR, WRITHEAD, WRITVAR**

### **Syntax**

**REWIND**      **nunite ;**

**nunite**            : user variable defined as an integer in the *command block* giving the Fortran unit number of the desired file (given by **OPENFILE** operator).

### **Example**

**REWIND**      **nunite;**

**N.B :** the FORTRAN subroutine called in PILOT is REWINDE : CALL REWINDE (NUNITE, IVSTAT).

<b>NUNITE</b>	INTEGER : Fortran unit number.
<b>IVSTAT</b>	Returned error code.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 531/851</a>

178

## ROCPELEM DIRECTIVE

This directive is used, in *command block*, after the **PERMINIT** and before **GOPERM** directives, to impose a special ROCP value on an element during the steady state. The ROCP coefficient multiplies the heat capacity of the walls of the element. The ROCP value is automatically reset to 1. after the steady state.

It is not available for catafuel calculation.

**Remark:** the default ROCP value used in **CATHARE** during the steady state is  $10^{-3}$ .

### Associated Keywords

**PERMINIT, GOPERM**

### Syntax

**ROCPELEM elem RCPHEL ;**

<b>elem</b>	: name of an element (axial, volume or threed).
<b>RCPHEL</b>	: keyword followed by a real number $> 0.$ , coefficient which multiplies the heat capacity of the walls.

**N.B :**the FORTRAN subroutine called in PILOT is ROCPELEM : Call ROCPELEM ( OOW, OOF, \*9999 ).

<b>OOW</b>	CHARACTER*8 name of the element.
<b>OOF</b>	DOUBLE PRECISION value of the RCPHEL coefficient.
<b>*9999</b>	fatal error treatment.

### Example

```
.....      END      DATA ; ...
RESTORE
;...
PERMINIT
...
ROCPELEM steamgen    0.02 ; ...
GOPERM ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 532/851

179

## ROROD DIRECTIVE

The **ROROD** directive is used to impose the value of the external reactivity due to the control rods drop. Access is performed in *command block*.

The ROROD directive has to be used if a core has been defined (**CORE** element) before the kinetics model computation (**GONEUT** directive) to initialize the external reactivity and after the **GONEUT** directive to modify the external reactivity.

### Associated Keywords

**CORE, GONEUT**

### Syntax

**ROROD**      core1      **VALUE**      roext;

<b>core1</b>	: core name.
<b>VALUE</b>	: keyword to indicate that external reactivity value have to be given.
<b>roext</b>	: real number defining the external reactivity expressed in \$, i.e. in pcm/BETA.

### Example

**ROROD**      Core1      **VALUE**      -5.D0 :

**NB** : The corresponding FORTRAN subroutine called in PILOT is ROROD.

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 533/851</a>

# 180

## RSETFUEL DIRECTIVE

The **RSETFUEL** directive, in *command block*, enables the user to adjust the fuel properties ( $\lambda_{UO_2}$ ,  $\lambda_{gap}$  and the porosity of  $UO_2$ ) on the basis of calculations done with the LIBELLULE (EDF) code, in order to take into account the local irradiation rate of the fuel.

It becomes effective when called and may be used several times during calculation.

### Associated Keywords

**FUELCHAR**, **STOPFUEL**

### Syntax

<b>RSETFUEL</b>	fuelchar1
<b>CAMP</b>	campnam
<b>BU</b>	bu
<b>POROS</b>	poros ;

<b>fuelchar1</b>	: name of the fuelchar element for which the fuel properties must be adjusted.
<b>CAMP campnam</b>	: keyword followed by a campaign name of 8 characters defining the state of the fuel to be used to take into account irradiation effects on a SCARFUEL type FUEL. The available campaign name and associated data must be defined in the private LIBFUEL*.f libraries and will be used to calculate adjusting coefficients.
<b>BU bu</b>	: keyword followed by a real number $\geq 0$ . defining the global burn up of the fuel. This burn up will be used to calculate adjusting coefficients.
<b>POROS poros</b>	: keyword followed by a real number $> 0$ . and $< 1$ . which defines the porosity of $UO_2$ . <b>NB</b> : the porosity of $UO_2$ is already defined in the <b>FUELCHAR</b> operator, but it can be modified during calculation, thanks to the <b>RSETFUEL</b> directive.

**NB** : this directive can be deactivated by directive **STOPFUEL**.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 534/851

<b>Example</b>
----------------

RSETFUEL      CARMOY  
CAMP            GR116  
BU                150.  
POROS          5.94D-2 ;

**NB :** the FORTRAN subroutine called in PILOT is RSETFUEL: CALL RSETFUEL ( CVAL, RVAL, \*9999).

CVAL(2)	CHARACTER*8 array.
CVAL(1)	:name of the fuelchar for which the fuel properties must be adjusted.
CVAL(2)	: campaign name.
RVAL(2)	DOUBLE PRECISION array containing the chosen values for the burn up and the porosity of <a href="#">UO<sub>2</sub></a> .

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 535/851

# 181

## RUPTURE OPERATOR

The **RUPTURE** operator creates a double ended break element. The RUPTURE operator **does not assign** the rupture (see **ASSIGN**) but only defines its characteristics. Used in the *data block*.

**N.B.** : Using the CIRCUIT operator, a shear double ended break can be integrated into a circuit only between two axial elements (since critical flow can be calculated only on meshed elements).

### Associated Keywords

**ASSIGN**, **VALBA FOR RG**, **WRIBA FOR RG**, **VALUE FOR RG**, **WRITE FOR RG**

### Syntax

```
elem=      RUPTURE
           junc1    sens1      junc2    sens2
           (WEIGHT ip);
```

<b>elem</b>	: rupture element.
<b>junci sensi</b>	: junction followed by a keyword defining the orientation of the junction in the element. This keyword is <b>USTREAM</b> or <b>DSTREAM</b> *.
<b>WEIGHT ip</b>	: OPTIONAL keyword followed by a positive integer which defines the weight of the element. The default value for the weight is 1.
<b>Definition</b>	: The weight of an element is the number of identical real elements it is simulating. The weight of elements is required for mass and energy balances.

The choice is insignificant since you have controlled that for the other element related to this junction, the other keyword is used.

### Example

```
break =      RUPTURE
           break1     USTREAM
           break2     DSTREAM
           WEIGHT     2 ;
rupgui =    RUPTURE
           USTREAM
           DSTREAM ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 536/851

182

## SAVE DIRECTIVE

The **SAVE** directive is used in the *command block* to save a reactor state into file V25\_3.RESTART. Each time the **SAVE** directive is used with a label number n, a reactor state record is done at this time. A reactor state data record is made of two parts :

1. A fixed part containing the geometrical, topological and some initialization values, constants during a computation.
2. A variable part containing all state variables of the computation which are time dependent.

Each saved reactor state includes all the data necessary to restart a calculation later on.

### Associated Keywords

**RESTORE, REACTOR, TABLE**

### Syntax

<b>SAVE</b>	<b>n</b>	<b>(REWIND)</b>
	<b>or</b>	<b>(APPEND)</b>
	<b>or</b>	<b>(DUMP)</b>
	<b>or</b>	<b>(DUMPONLY) ;</b>

<b>n</b>	: integer > 0 and < 999 which must be used to give a label to the reactor state.
<b>REWIND</b>	: OPTIONAL keyword indicating to the code that the current saving must be performed with label n at the beginning of the file V25_3.RESTART. The previous savings are overwritten. Note that Cathare V2.5_3 cannot manage more than 30 saved states in a single V25_3.RESTART file.
<b>APPEND</b>	: OPTIONAL keyword indicating to the code that the current saving must be concatenated to the ones previously written in the file V25_3.RESTART (equivalent to SAVE n).
<b>DUMP</b>	: OPTIONAL keyword indicating to the code that the FAST.H has to be saved in the V25_3.RESTART file. The standard save is replaced by this one. The save is binary identical to the calculation without save.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 537/851

**DUMPONLY** : OPTIONAL keyword indicating to the code that the FAST.H has to be saved in the V25\_3.DUMP\_FAST.BIN file. The standard save in the V25\_3.RESTART is also possible.  
 Use only once.  
 The save is binary identical to the calculation without save.

**NB1** : label 999 is assigned to a special reactor state activated automatically by Cathare after an incident during computation ( error, no convergence, ... ). It contains the state of the reactor computation just before the incident.

**NB2** : the FORTRAN subroutine called in PILOT is SAVE : CALL SAVE (COPTIO, NLABELL, \*9999).

<b>COPTIO</b> <b>NLABELL</b>	CHARACTER*8 saving option. INTEGER state number. In case of simulator use, COPTIO may take the value ‘APPEND’ or ‘VECINI’. Then the NLABELL value has no meaning and is not used.
---------------------------------	---

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 538/851

# 183

## SCALAR OPERATOR

The **SCALAR** operator is used to have the **number** of the scalar point (of a 1D-meshing) corresponding to the nearest scalar point of a given curvilinear x-axis of a meshing. When the given x-axis is equidistant from two scalar points, the result number will correspond to the first of these points in the mesh order.

**Warning :** A scalar point defined in the **data block** is unknown in the **command block**. So it has to be defined or redefined in the command block.

### Associated Keywords

SEGMENT, VECTOR, XAXIS

### Syntax

```
ipi =      SCALAR      elemi      zj ;
```

**elemi** : name of the axial element.  
**zj** : real number  $\geq 0$ . representing a curvilinear coordinate.

### Example

In the data block the following meshing is created :

```
p1 =      XAXIS      0.0 ;
p6 =      XAXIS      12.0 ;
t1 =      p1          SEGMENT      6           COS           0.           p6 ;
MESH     elem1       t1 ;
```

In the command block we can define 3 integers ip3, ip4, ip5 :

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 539/851

ip3 = SCALAR elem1 4.5 ;  
ip4 = SCALAR elem1 7.0 ;  
ip5 = SCALAR elem1 9.6 ;

The values given by **CATHARE** to the variables are the following :

ip3= 3  
ip4= 4  
ip5= 6

**Warning** : The **command block** invokes in the PILOT subroutine the ISCALA function, corresponding to SCALAR operator, which returns an integer.

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 540/851</a>

184

## SCRAM DIRECTIVE

The **SCRAM** directive is used to acquire external reactivity data due to the control rods drop. The law (time, reactivity) is introduced in relative time, time zero being the instant when this directive is called. Used in the *command block*.

The SCRAM directive can only be used if the point kinetics model computation has begun (**GONEUT** directive) and then if a core (**CORE** element) has been defined.

**N.B.** : During a computation, the SCRAM directive can only be used once for a given core.

### Associated Keywords

**CORE, GONEUT**

### Syntax

<b>SCRAM</b>	core1 <b>TIME</b> <b>REALIST</b> x1                   ...                   xn <b>REACTIVITY</b> <b>REALIST</b> y1                   ...                   yn ;
--------------	---

<b>core1</b>	: core
<b>TIME</b>	: keyword to indicate that the time values are to be given. The times are taken with respect to the time when the directive is applied.
<b>REALIST xi</b>	: keyword followed by a list of time values (s) (real numbers).
<b>REACTIVITY</b>	: keyword to indicate that external reactivity values are to be given.
<b>REALIST yi</b>	: keyword followed by a list of real numbers defining the external reactivity values (expressed in \$, i.e. in pcm/BETA).

### Example

<b>SCRAM</b>	core1 <b>TIME</b> <b>REALIST</b> 0.D0           1.D0           6.D0           1.D4 <b>REACTIVITY</b> <b>REALIST</b> 0.D0           -4.D-3          -6.D-1          -5.D0 ;
--------------	--

**N.B.** : the corresponding FORTRAN subroutine called in PILOT is SCRAM.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 541/851

# 185

## SEGMENT OPERATOR

The **SEGMENT** operator defines in the *data block* a straight line joining two points. In **CATHARE**, internal representation, the fluid flows along this segment. A segment carries a mesh portion starting and ending on vector (velocity) nodes.

```

x—— 0—— x—— 0—— x      2
                  meshes
P1      01      P2      02      P3

```

P1, P2, P3 are vector points for which velocities are known, O1, O2 are scalar points for which pressure, void fraction, enthalpies and non-condensable gases mass fractions are known.

### Associated Keywords

**SCALAR, VECTOR, XAXIS**

### Syntax

```

meshl      p1          SEGMENT    N           p2          COS          xcos
          (DATA        x1          x2          ...         xN)
          (RATIO       r)
...
SEGMENT   ...
...
;
```

<b>meshl</b>	: object of the type ‘mesh’
<b>p1</b>	: beginning point of the segment
<b>p2</b>	: end point of the segment
<b>pi</b>	: other point of the meshing
<b>N</b>	: If N is positive, N equal meshes will be created or if the keyword DATA was given N meshes from x1 to xN in length will be created. If N is negative, N meshes will be created and their length calculated according to the RATIO coefficient.
<b>COS xcos</b>	: keyword followed by a real number between –1. and +1. representing the cosine of the angle between the segment (tangent taken from scalar node) and the upward vertical.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 542/851

- DATA x1 x2 ..xN** : OPTIONAL keyword followed by N strictly positive real numbers indicating the lengths of the N meshes.  
The value of N (N > 0) is mandatory.
- RATIO r** : OPTIONAL keyword followed by a real number “r” used to define the ratio of the lengths of adjacent meshes.  
The value of N (N < 0) is mandatory.

<b>Example</b>
----------------

```

p1 =           XAXIS      0.;  

p2 =           XAXIS      10.;  

p3 =           XAXIS      20.;  

* segment between P1 and P2, 4 meshes of equal length :  

t1 =           p1          SEGMENT    4           p2          COS        0.  

Ta5 =          p1          SEGMENT    1           p2          COS        -1.  

                    SEGMENT    3           p3          COS        -0.5 ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 543/851

# 186

## SENSOR OPERATOR

The **SENSOR** operator creates in *data block* a SENSOR submodule by defining its characteristics. A sensor is a passive element. It is used in the command block to provide access to physical variables of the plant using **CCV** (see **VALUE FOR SENSOR** directive for sensor element). Any required number of sensors can be defined in **CATHARE**, but 200 is the maximum supported by the reader in standard installation [2]. A sensor can be defined on an AXIAL or VOLUME element (except the SWLEVEL sensor that may be defined also on a THREED element).

### Associated Keywords

**VALUE FOR SENSOR**, **(MPa)UTILx**, **VALUEFLD**, **VALBA**, **VALUFEAU**

## 186.1 Temperature sensor

### Syntax

sens =	<b>SENSOR</b>	<b>TEMP</b>	<b>AXIAL</b>	<b>VOLUME</b>	<b>elem</b>	<b>ip</b>	<b>ELEV</b>	
	or				elem			;

<b>sens</b>	: name of the SENSOR (max 8 characters)
<b>elem</b>	: pipe (if AXIAL) or volume (if VOLUME) name
<b>ip</b>	: <b>scalar</b> point (if AXIAL) defining the location of the sensor
<b>ELEV z</b>	: keyword followed by the elevation ( <i>m</i> ) of the sensor relative to the bottom of the volume

### Example

sens =	<b>SENSOR</b>	<b>TEMP</b>	<b>VOLUME</b>	<b>pressu</b>	<b>ELEV</b>	
--------	---------------	-------------	---------------	---------------	-------------	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 544/851

## 186.2 Wall temperature sensor

### Syntax

```
sens =      SENSOR      TEMPWALL    WALL      wallnam      ELEV      z ;
```

**sens** : name of the SENSOR (max 8 characters)  
**wallnam** : wall name (belonging to an AXIAL or a VOLUME element)  
**ELEV z** : keyword followed by the elevation (*z*) of the sensor from the bottom of the wall

### Example

```
sens =      SENSOR      TEMPWALL    WALL      el8a        ELEV      5. ;
```

## 186.3 Pressure sensor

### Syntax

```
sens =      SENSOR      PRESSURE
          AXIAL       elem        ip        (ELEV      z)
or        VOLUME     elem        ELEV      z
                  ;
```

**sens** : name of the SENSOR (max 8 characters)  
**elem** : pipe (if AXIAL) or volume (if VOLUME) name  
**ip** : **scalar** point (if AXIAL) defining the location of the sensor (it is the nearest scalar point from the real position of the sensor).  
**ELEV z** : for VOLUME type SENSOR: keyword followed by the elevation (*z*) of the sensor from the bottom of the volume.  
           : for AXIAL-type SENSOR: OPTIONAL keyword followed by the real position (*z*) of the sensor from the beginning of the AXIAL element. If it is not equal to 0., then the pressure value returned by the SENSOR is that of the real curvilinear coordinate of the SENSOR instead of that of the nearest SCALAR point (ip).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 545/851

### Example

```

sens =      SENSOR      PRESSURE    VOLUME
           PRESSU     ELEV        5.D0      ;
IP1 =       SCALAR     DOWNCOM1   2.D0 ;
sens1 =     SENSOR      PRESSURE    AXIAL
           DOWNCOM1   IP1 ;
sens2 =     SENSOR      PRESSURE    AXIAL
           DOWNCOM1   IP1        ELEV        2.D0 ;

```

If IP1 does not correspond to the exact position of a SCALAR point of DOWNCOM1, the VALUE in sensor SENS1 will be the pressure at the Scalar point as near 2.D0 meters as possible, whereas VALUE directive on sensor SENS2 will return the exact pressure at the exact position 2.D0 meters from the first VECTOR mesh of DOWNCOM1.

## 186.4 Flowrate sensor

### Syntax

```
sens =      SENSOR      FLOWRATE   AXIAL      elem      ip ;
```

**sens** : Name of the SENSOR (max 8 characters)  
**elem** : Pipe name  
**ip** : **vector** point defining the sensor location

### Example

```
sens =      SENSOR      FLOWRATE   AXIAL      el8a      5;
```

## 186.5 Mailsipa sensor

### Syntax

```
sens =      SENSOR      MAILSIPA   AXIAL      elem      ip;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 546/851

**sens** : Name of the SENSOR (max 8 characters)  
**elem** : Pipe name  
**ip** : **vector** point defining the sensor location

#### Example

```
sens = SENSOR MAILSIPA AXIAL el8a node5 ;
```

## 186.6 Acti sensor

#### Syntax

sens =	SENSOR	ACTI or	AXIAL VOLUME	elem elem	ip <b>ELEV</b>	z ;
--------	--------	------------	-----------------	--------------	-------------------	-----

**sens** : Name of the SENSOR (max 8 characters)  
**elem** : Pipe (if AXIAL) or Volume (if VOLUME) name  
**ip** : **scalar** point (if AXIAL) defining the sensor location  
**ELEV z** : keyword followed by the elevation (z) of the sensor from the bottom of the volume

#### Example

```
SENS = SENSOR ACTI VOLUME PRESSU ELEV 5.D0 ;
```

## 186.7 Actisipa sensor

#### Syntax

sens =	SENSOR	ACTISIPA	AXIAL	elem	ip;
--------	--------	----------	-------	------	-----

**sens** : Name of the SENSOR (max 8 characters)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 547/851

**elem** : Pipe name  
**ip** : **scalar** point defining the sensor location

#### Example

```
sens = SENSOR ACTISIPA AXIAL el8a node5 ;
```

## 186.8 Qactisipa sensor

#### Syntax

```
sens = SENSOR QACTSIPA AXIAL elem ip;
```

**sens** : Name of the SENSOR (max 8 characters)  
**elem** : Pipe name  
**ip** : **vector** point defining the sensor location

#### Example

```
sens = SENSOR QACTSIPA AXIAL el8a node5 ;
```

## 186.9 Ultrason sensor

#### Syntax

```
sens = SENSOR ULTRASON AXIAL elem ip ;
```

**sens** : Name of the SENSOR (max 8 characters)  
**elem** : Pipe name  
**ip** : **scalar** point defining the sensor location

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 548/851

<b>Example</b>
----------------

```
SENS =      SENSOR      ULTRASON    AXIAL      el8a      node5 ;
```

## 186.10 Swellevel sensor

It is used to calculate the swell level in a vertical zone of a 3D component or in a vertical axial element.

**Warning :**

1. For an axial : it must be vertical.
2. For a 3D : it must have a Z component.

<b>Syntax</b>
---------------

```
sens =      SENSOR      SWLLEVEL
          AXIAL       elem        ALFA        almax
          or
          THREED     elem        ALFA        almax
                      zoname1
          or
                      zoname1    ibeg iend
                                jbeg jend
                                kbeg kend
                      [zoname2
          or
                      zoname2    ibeg iend
                                jbeg jend
                                kbeg kend ]
;
;
```

**sens** : Name of the SENSOR (max 8 characters).  
**elem** : Pipe or Threed element name.  
**almax** : Limit value of void fraction for which the mesh is considered empty and used in the mixture level calculation  
**zoname1** : Name of the first zone defining the controlled zone area.  
**ibeg iend jbeg jend** : Definition of the threed zone (see ZONEDEF in MESH directive for THREED operator) if not already defined.  
**kbeg kend** : optional name of the second zone used to define the reference surface.

**N.B.:** If “zonamei” has already been defined in MESH directive, the name use is enough else, in addition to its name, the user has also to give the definition of the threed zone.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 549/851

<b>Examples</b>
-----------------

```

almaxi=      0.9D0 ;

CAPT1 =      SENSOR      SWLLEVEL    THREED
              cuve        ALFA         almaxi      ZDOWCO      ;
CAPT2 =      SENSOR      SWLLEVEL    THREED
              cuve        ALFA         almaxi      ZCOEUR
                               1 7
                               1 4
                               5 16 ;
CAPT5 =      SENSOR      SWLLEVEL    AXIAL
              tgar1       ALFA         almaxi      ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 550/851

187

## SGCARACT OPERATOR

The **SGCARACT** operator used in the *data block* creates a POINT STEAM GENERATOR object and defines its characteristics.

The object thus created will be taken into account in the wall by using POINTSG keyword (see [WALL](#)).

The **SGCARACT** operator can only be used for AXIAL elements.

### Associated Keywords

[GVPOWER](#), [WALL](#)(POINTSG), [SGFEED](#), [VALUE FOR SG CARACT](#), [WRITE FOR SG CARACT](#)

### Syntax

```
carac1 =      SGCARACT    wall1
                FEEDWT      law1
                LIQFLOW     law2
                STMFLOW     law3
                VALVFLOW    law4
                TOTV        vol1
                INVLIQ      vol2
                FOULING     foul
                INIP        press ;
```

<b>carac1</b>	: sgcarac-type object.
<b>Wall1</b>	: name of the wall.
<b>FEEDWT law1</b>	: keyword followed by the name of a ‘law’-type object defining the law of feedwater temperature (°C) as a function of time.
<b>LIQFLOW law2</b>	: keyword followed by the name of a ‘law’-type object defining the normalized law for liquid flow as a function of time.
<b>STMFLOW law3</b>	: keyword followed by the name of a ‘law’-type object defining the normalized law for steam flow as a function of time.
<b>VALVFLOW law4</b>	: keyword followed by the name of a ‘law’-type object defining the law of valve flow (kg/s) as a function of pressure (Pa). The first pressure must be the set pressure of the valve on the steam line.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 551/851

- TOTV vol1** : keyword followed by a real number > 0., defining the total volume of the steam generator (m<sup>3</sup>).
- INIVLIQ vol2** : keyword followed by a real number > 0., defining the initial volume of water in the secondary (m<sup>3</sup>).
- FOULING foul** : keyword followed by a real number > 0., defining the fouling (increase in thermal resistance due to a deposit on the tube walls).
- INIP press** : keyword followed by a real number > 0., defining the secondary initial pressure (Pa).

<b>Example</b>
----------------

```

law1 =      LAW      'TIME'      'TEMPERATURE'
            0.        220.
            1.        220. ;
law2 =      LAW      'TIME'      'FLOW'
            0.        1.
            1.        1. ;
law3 =      LAW      'TIME'      'FLOW'
            0.        1.
            1.        1. ;
law4 =      LAW      'PRESSURE'  'FLOW'
            73.D5    0.
            74.D5    0.1
            81.D5    100. ;
carac1 =    SGCARACT genvapi   FEEDWT    law1
            LIQFLOW   law2
            STMFLOW   law3
            VALVFLOW  law4
            TOTV      162.96
            INIVLIQ   48.90
            FOULING   0.
            INIP       61.D5 ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 552/851

# 188

## SGFEED DIRECTIVE

The **SGFEED** directive is used in the *command block* during a computation to modify the laws relating to feed water temperature, feed water flow rate, steam flow rate and safety valve flow rate for a **point steam generator**. These laws are introduced in absolute time and will replace the laws given initially with the **SGCARACT** operator.

### Associated Keywords

**SGCARACT, WALL**

### Syntax

<b>SGFEED</b> <b>(FEEDWT</b> <b>      elem1</b> <b>      TIME</b> <b>      TEMPERATURE</b> <b>      REALIST</b> <b>      xf1</b> <b>      ...</b> <b>      xfn</b> <b>      yf1</b> <b>      ...</b> <b>      yfn)</b> <b>      LIQFLOW</b> <b>      TIME</b> <b>      FLOW</b> <b>      REALIST</b> <b>      xl1</b> <b>      ...</b> <b>      xln</b> <b>      yl1</b> <b>      ...</b> <b>      yln)</b> <b>      STMFLOW</b> <b>      TIME</b> <b>      FLOW</b> <b>      REALIST</b> <b>      xs1</b> <b>      ...</b> <b>      xsn</b> <b>      ys1</b> <b>      ...</b> <b>      ysn)</b> <b>      VALVFLOW</b> <b>      PRESSURE</b> <b>      REALIST</b> <b>      xv1</b> <b>      ...</b> <b>      xvn</b> <b>      FLOW</b> <b>      REALIST</b> <b>      yv1</b> <b>      ...</b> <b>      yvn) ;</b>
---

<b>elem1</b> <b>FEEDWT</b> <b>      :</b> <b>      name of the 'sgcaract'-type object</b> <b>      :</b> <b>      OPTIONAL keyword indicating that the 'TIME' 'FEEDWATER TEMP' law (feed water temperature (°C) as a function of time) is to be read. This keyword is followed by realists giving the new values of the law.</b>
<b>LIQFLOW</b> <b>      :</b> <b>      OPTIONAL keyword indicating that the 'TIME' 'LIQUID FLOW' law (normalized liquid flow as a function of time) is to be read. This keyword is followed by realists giving the new values of the law.</b>
<b>STMFLOW</b> <b>      :</b> <b>      OPTIONAL keyword indicating that the 'TIME' 'STEAM FLOW' law (normalized steam flow as a function of time) is to be read. This keyword is followed by realists giving the new values of the law.</b>

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 553/851

**VALVFLOW** : OPTIONAL keyword indicating that the ‘PRESSURE’ ‘VALVE FLOW’ law is to be read. This keyword is followed by realists giving the new values of the law.

**Example**

SGFEED	genvapi				
FEEDWT	TIME	REALIST	0.	100.	1000.
	TEMPERATURE	REALIST	220.	220.	200.
LIQFLOW	TIME	REALIST	0.	1000.	
	FLOW	REALIST	1.1	1.1 ;	

**N.B** : the FORTRAN subroutine called in PILOT is GVPFEED.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 554/851

189

## SGTR OPERATOR

The **SGTR** operator defines in the *data block* the characteristics of a Steam Generator Tube Rupture (**SGTR**). A SGTR can be defined only between two **AXIAL** elements. These elements can be included in two different circuits (primary and secondary) or in a single circuit representing the whole reactor (**IMPLICIT** option must be used). It is not necessary for these 2 elements to exchange via an **EXCHANGER** if **IMPLICIT** is used. In addition, these two circuits must be defined with the same non-condensable gases.

The SGTR is always located in one point. This point is defined with the keyword **UNIQ** or, if the keyword **TABL** is used, in the opening command **OPENBREK**. The **TABL** option gives the possibility to choose the SGTR point in a segment of the meshing, defined both in primary and secondary circuit by correspondence table.

The SGTR can either model small leaks (keyword **GVFUIT**) or one or several fully ruptured tubes (keyword **GVGUIL**). The physical model is different for these two cases.

The SGTR operator only defines a SGTR (and located in case of keyword **UNIQ**), **but does not open it** (see **OPENBREK**).

**NB:** using **ENABLE** directive to activate the SGTR is possible only if **UNIQ** keyword was used in SGTR definition. In that case there is no delay in the opening and the break is fully open.

### Associated Keywords

**OPENBREK, ENABLE, DISABLE, VALBA FOR A SGTR, VALUE FOR A SGTR**

### Syntax

<b>B =</b>	<b>SGTR</b> <i>circtot</i> <b>IMPLICIT</b> <i>or</i> <b>EXPLICIT</b> <b>SECT</b> <i>sect</i> <b>UNIQ</b> <i>elem<sub>prim</sub></i> <i>scal<sub>prim</sub></i> <i>elem<sub>sec</sub></i> <i>scal<sub>sec</sub></i>
<b>or</b>	<b>TABL</b> <i>elem<sub>prim</sub></i> <i>elem<sub>sec</sub></i> <b>SEGMENT</b> <i>IV<sub>sec1</sub></i> <i>IV<sub>sec2</sub></i> <b>DIRECT</b> <i>(or</i> <b>REVERSE</b> <b>SEGMENT</b> <i>IV<sub>prim1</sub></i> <i>IV<sub>prim2</sub></i> <b>GVGUIL</b> <i>...</i> <i>ntr</i>

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 555/851

or                   **GVFUIT**  
 or                   **BETHSY**        deltaz  
**(SINGULAR**      **PRIMARY**     sing1)  
**(SINGULAR**      **SECONDARY** sing2)       ;

<b>circtot</b>	: reactor including the primary and secondary circuits or a single circuit.
<b>IMPLICIT</b> or <b>EXPLICIT</b>	: keyword indicating that the SGTR element will be implicit ( <b>IMPLICIT</b> ) or explicit ( <b>EXPLICIT</b> ).
<b>SECT sect</b>	: keyword followed by a real number > 0. defining the maximum cross-section of the SGTR (m <sup>2</sup> ).
<b>UNIQ</b>	: keyword indicating that the SGTR is defined in only one point (and thus can't be moved during the transient); it is followed by:
<b>elem<sub>prim</sub></b>	: axial element belonging to the primary circuit.
<b>scal<sub>prim</sub></b>	: scalar point belonging to the primary element meshing ; the SGTR is defined in this point.
<b>elem<sub>sec</sub></b>	: axial element belonging to the secondary circuit.
<b>scal<sub>sec</sub></b>	: scalar point belonging to the secondary element ; the SGTR is defined in this point.
<b>or</b>	
<b>TABL</b>	: keyword followed by the segment meshing data, giving the corresponding points between primary and secondary side.
<b>Elem<sub>prim</sub> elem<sub>sec</sub></b>	: axial elements belonging to the primary circuit, then the secondary circuit.

<b>SEGMENT</b>	: keyword followed by two vector points which must belong to the axial meshing of the secondary element and which define the start and the end of the secondary sgtr zone. These two points must be given in the order in which the secondary hydraulic meshing has been described.
<b>IV<sub>sec1</sub> IV<sub>sec2</sub></b>	
<b>DIRECT</b> <b>(or REVERSE)</b>	: keyword preceding the pair of primary points when primary and secondary meshings are described in the same direction. (DIRECT is replaced by REVERSE when primary and secondary meshings are described in the opposite direction).
<b>IV<sub>prim1</sub> IV<sub>prim2</sub></b>	: vector points which must belong to the axial meshing of the primary element and which define the start and the end of the primary sgtr zone. These two points must be given in the order in which the primary hydraulic meshing has been described.

**To be  
repeated  
as many  
times as  
number  
of  
segments**

<b>GVGUIL ntr</b>	: keyword indicating that the sgtr corresponds to one broken tube or more. It is followed by an integer which defines the number of broken tubes corresponding to the maximum cross-section "sect".
<b>or</b>	
<b>GVFUIT</b>	: keyword indicating that the SGTR corresponds to a small leak (sect < one tube section).

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 556/851</a>

**BETHSY deltaz** : keyword indicating that the SGTR is simulated by a pipe connecting primary and secondary circuit (case of BETHSY loop); it is followed by a real number defining the height between the break of the primary side and the break of the secondary side (height of the connecting pipe).

**(SINGULAR PRIMARY sing1 )** : OPTIONAL keyword (SINGULAR). If given, this word is followed by a keyword defining the side where head loss coefficient is defined (PRIMARY or SECONDARY), then by a real number defining the head loss coefficient on this side.

**(SINGULAR SECONDARY sing2)**

### Examples

Example 1:

```

prtg1 = SCALAR lgvvapi 21.014 ;
prtg2 = SCALAR ldownmi 15.544 ;
SGTR1 = SGTR circtot EXPLICIT SECT 6.090d-3
UNIQ genvapi prtg1
downcomi prtg2
GVGUIL 2
SINGULAR PRIMARY .6 ;

```

Example 2:

if RISA1, RISA2, RISA3 are vector points of riseri and PCHA12, PCHA13 and PCHA16 vector points of genvapi

```

SGTR2 = SGTR circtot IMPLICIT SECT 3.045d-3
TABL genvapi riseri
SEGMENT RISA1 RISA2 DIRECT
PCHA12 PCHA13
SEGMENT RISA2 RISA3 DIRECT
PCHA13 PCHA14
SEGMENT RISA2 RISA3 REVERSE
PCHA14 PCHA15
SEGMENT RISA1 RISA2 REVERSE
PCHA15 PCHA16
GVFUIT ;

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 557/851

190

## SHAFTMOD DIRECTIVE

The **SHAFTMOD** directive is used to modify the characteristics of an alternator of a SHAFT during a transient, in the *command block*.

### Associated Keywords

SHAFT, STARALTR, STARSHAF, STOPALTR, STOPSHAF

### Syntax

<b>SHAFTMOD</b>	<b>char</b>	
	<b>MOD</b>	<b>SIMP</b>
	<b>or</b>	<b>DET</b>
	<b>or</b>	<b>FIXPOWER</b>
	<b>INERTIA</b>	<b>z0</b>
	<b>AT</b>	<b>at</b>
	<b>AC</b>	<b>ac</b>
	<b>BA</b>	<b>ba</b>
	<b>CA</b>	<b>ca</b>
	<b>DA</b>	<b>da</b>
	<b>CO</b>	<b>co</b>
	<b>LOAD</b>	<b>load</b>
	<b>RPMS</b>	<b>rpms</b>
		<b>;</b>

**char** : name of the shaft whose characteristics will be modified.  
**MOD** : keyword followed by the model of resolution. This is followed by :  
**SIMP** : keyword indicating that the SIMPLE model is used (with constant rotating speed)  
**or**  
**DET** : keyword indicating that the DETAILED model is used.  
The Alternator is supposed to be connected to a large electric network: in such a case, the alternator power is variable and computed from :  $co \cdot \sin(\phi)$ " where  $\phi$  is calculated with  $\frac{d\phi}{dt} = OM - OMS$ , OM being the current rotation speed and OMS being the synchronism rotation speed.

or

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 558/851</a>

<b>FIXPOWER</b>	: keyword indicating that the DETAILED model is used but the Alternator is supposed to be in “house load operation” situation : in such a case, the alternator power is imposed to the value it had at the time of the shaftmod directive. It may be changed via C0 and via the <a href="#">CCV</a> . $\phi$ : $\phi$ is constant and the power is computed from $co \cdot \sin(\phi)$
<b>INERTIA</b>	: keyword followed by a real number $\geq 0.$ , representing the inertia of the shaft (in $\text{kg} \cdot \text{m}^2$ ).
<b>AT</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the turbines friction torque (in W) : $C_{ft} = \frac{at}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2$
<b>AC</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the compressors friction torque (in W) : $C_{fc} = \frac{ac}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2$
<b>BA</b>	: keywords followed by real numbers $\geq 0.$ , representing the coefficients of the alternator friction torque (in W) : $C_{fa} = \frac{ba}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2 + \frac{ca}{\omega_{ref}} \text{load}$ , see LOAD definition below
<b>CA</b>	
<b>DA</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the damping expression (in N.m) : $Damping = da \left[ 1 - \frac{\omega_{ref}}{\max(\omega, 4.2 \cdot 10^{-4})} \right] \text{load}$ , see LOAD definition below
<b>CO</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the electric torque (in W) : $C_{elec} = \frac{co \cdot \max(\sin\phi, 0)}{\max(\omega, 4.2 \cdot 10^{-4})} \text{load}$ , see LOAD definition below
<b>LOAD</b>	: keyword followed by a real number $0. \leq \text{load} \leq 1.$ , representing the alternator load level
<b>RPMS</b>	: keyword followed by a real number $> 0.$ , representing the synchronism speed (in rpm).

### Example

```

SHAFTMOD    arbre1
MOD          SIMP
INERTIA      6.D2
AT           5.D2
AC           3.5D2
BA           1.9D7
CA           1.3D7
DA           4.8D6
CO           2.59D9
LOAD         .97D0
RPMS        3000.D0
;
```

**NB :** This directive generates several calls to the FORTRAN subroutines RPMOD0, RPMOD1, RPMOD2, RPMOD3.

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 559/851

# 191

## SHAFT OPERATOR

The **SHAFT** operator creates, in the *data block*, a “turbo machine” object by close coupling of one or several **TCOMCHAR** elements (TURBINE or compressor).

An optional ALTERNATOR can also be added to this coupling.

The SHAFT is located on a vector mesh of an axial element, which is the location of the MASTER element (see the definition below).

The SHAFT is automatically connected when it is defined.

### Associated Keywords

**TCOMCHAR, STARALTR, STARSHAF, STOPALTR, STOPSHAF, SHAFTMOD**

### Syntax

char=	<b>SHAFT</b>				
	<b>MASTER</b>	tcname <sub>1</sub>			
	<b>SLAVE</b>	n	tcname <sub>2</sub>	...	tcname <sub>n+1</sub>
	<b>(ALTERNAT</b>				
	<b>MOD</b>	<b>SIMP</b>			
	or	<b>DET</b>			
	<b>INERTIA</b>	z0			
	<b>AT</b>	at			
	<b>AC</b>	ac			
	<b>BA</b>	ba			
	<b>CA</b>	ca			
	<b>DA</b>	da			
	<b>CO</b>	co			
	<b>LOAD</b>	load			
	<b>RPMS</b>	rpms ) ;			

<b>MASTER</b>	: keyword followed by the name of the TCOMCHAR which imposes the velocity to the group.
<b>SLAVE</b>	: keyword followed by an integer $0 \leq n \leq 5$ and by the n names of the TCOMCHAR whose velocity is imposed by the MASTER.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 560/851

<b>ALTERNAT</b>	: optional keyword indicating that an alternator is coupled to the group. This is followed by :
<b>MOD</b>	: keyword followed by the model of resolution. This is followed by :
<b>SIMP</b> or <b>DET</b>	: keyword indicating that the SIMPLE model is used (when the rotating speed is constant). : keyword indicating that the DETAILED model is used. The Alternator is supposed to be connected to a large electric network: in such a case, the alternator power is variable and computed from : $co \cdot \sin(\phi)$ " where $\phi$ is calculated with $\frac{d\phi}{dt} = OM - OMS$ , OM being the current rotation speed and OMS being the synchronism rotation speed.
<b>INERTIA</b>	: keyword followed by a real number $\geq 0.$ , representing the inertia of the shaft (in $\text{kg.m}^2$ ).
<b>AT</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the turbines friction torque (in W) : $Cf_t = \frac{at}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2$
<b>AC</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the compressors friction torque (in W) : $Cf_c = \frac{ac}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2$
<b>BA</b>	: keywords followed by real numbers $\geq 0.$ , representing the coefficients of the alternator friction torque (in W) : $Cf_a = \frac{ba}{\omega_{ref}} \left( \frac{\omega}{\omega_{ref}} \right)^2 + \frac{ca}{\omega_{ref}} load$ , see LOAD definition below
<b>CA</b> <b>DA</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the damping expression (in N.m) : $Damping = da \left[ 1 - \frac{\omega_{ref}}{\max(\omega, 4.2 \cdot 10^{-4})} \right] load$ , see LOAD definition below
<b>CO</b>	: keyword followed by a real number $\geq 0.$ , representing the coefficient of the electric torque (in W) : $C_{elec} = \frac{co \cdot \max(\sin\phi, 0)}{\max(\omega, 4.2 \cdot 10^{-4})} load$ , see LOAD definition below
<b>LOAD</b>	: keyword followed by a real number $0. \leq load \leq 1.$ , representing the alternator load level
<b>RPMS</b>	: keyword followed by a real number $> 0.$ , representing the synchronism speed (in rpm).

### Examples

```

arbre1      = SHAFT
MASTER      compr1
SLAVE       2           turb1        compr2
ALTERNAT
MOD         DET
INERTIA     600.D0
AT          500.D0
AC          350.D0
BA          1.9D7
CA          1.3D7
DA          4.8D6
CO          2.59D9
LOAD        1.D0
RPMS        3000.D0;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 561/851

192

## SINGULAR DIRECTIVE

The **SINGULAR** directive is used in the *data block* to assign the singular pressure drop coefficients of an element. These singular pressure drop coefficients may be Reynolds number dependant if a law is specified by user.

Singularity coefficients are specific to the type of element : AXIAL, TEE-BRANCH, VOLUME, or THREED

**Definition of singularity coefficients for each phase *k* (liquid or gas):**

$$\Delta P_{sing_k} = 0.5 \times K \times \alpha_k \times \rho_k \times V_k \times V_k$$

**Note :**

1. singularity coefficients are defined on vector points.
2. singularity coefficients may be constant or Reynolds number dependant
3. if singularity coefficients are constants :
  - (a) a given vector point can be associated with more than one singularity coefficient, in which case the **coefficients are cumulated**
  - (b) SINGULAR directive can be repeated as many times as necessary for the same element or vector point or segment. The coefficients are then cumulated.
4. if singularity coefficients are Reynolds number dependant, they can be defined only once for a given vector point
5. singularities at a junction are not always taken into account : it depends on the type of the adjacent element and on the sign of the velocities at this junction.

### Associated Keywords

**AXIAL, VOLUME, THREED, TEE, SINGUMOD, VALVE**

## 192.1 Singularities of a 1-D element

If the pipe represents the secondary side of a steam generator (riser), an OPTIONAL keyword **SGPLATE** may be used to model the head losses due to the steam generator plates. In this case we have :  $\Delta P_{sing_k} = 0.5 \times K \times \alpha_k \times \rho_k \times V_k \times J$  with  $J = |V_G| + (1 - \alpha)|V_L|$

This model must not be used at a junction, only on internal points.

Singularity coefficients are defined on vector points of an axial element. The points can be entered :

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 562/851

1. one by one
2. in sequence (for points with identical values of singularity)
3. for a whole segment if the values of the coefficients are constant at all vector points of the segment.

### Syntax

<b>SINGULAR</b>	<b>elem</b>						
<b>POINT</b>	<b>p1</b>						
		<b>(SGPLATE)</b>					
		<b>POSITIVE</b>	<b>zp</b>	or	<b>lawp</b>		
		<b>NEGATIVE</b>	<b>zm</b>	or	<b>lawm</b>	;	
Or							
<b>POINT</b>	<b>(p1</b>	<b>AND</b>	<b>p2</b>	...	<b>AND</b>	<b>pN)</b>	
		<b>POSITIVE</b>	<b>zp</b>	or	<b>lawp</b>	<b>(SGPLATE)</b>	
		<b>NEGATIVE</b>	<b>zm</b>	or	<b>lawm</b>	;	
Or							
<b>SEGMENT</b>	<b>p1</b>	<b>p2</b>		<b>(SGPLATE)</b>			
				<b>POSITIVE</b>	<b>zp</b>	or	<b>lawp</b>
				<b>NEGATIVE</b>	<b>zm</b>	or	<b>lawm</b>
							;

**elem** : axial element.  
**POINT** : keyword to indicate that the singularity coefficients are given point by point.  
**pi** : vector point belonging to the axial mesh of the element (integer defined by **XAXIS** or **VECTOR** operator).  
**SGPLATE** : OPTIONAL keyword requesting the use of a special model (see above).  
**POSITIVE, NEGATIVE** : keywords to introduce the values in the direction of positive velocities or in the direction of negative velocities. Positive meaning that the fluid flows from the first mesh to the last mesh of the pipe.  
**zp, zm** : real numbers defining singular head loss coefficients.  
**lawp, lawm** : laws defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW 'REYNOLDS' 'KSING')  
**SEGMENT** : keyword to read a segment on which singular frictions are to be defined.  
**pi pj** : vector point (integers) belonging to the axial mesh of the element and which define the beginning and the end of the segment.

### Example

Assuming that p2, p3, p4, p5 and p7 are vector points of the axial element CHANNEL

**SINGULAR** channel

SINGULAR	POINT p5 channel POINT	POSITIVE (p2)	2. AND	NEGATIVE p3	4. , AND	p4) SGPLATE
SINGULAR	POSITIVE channel SEGMENT	2.	NEGATIVE	4. ;		
SINGLAW	POSITIVE =	p3 2. LAW	p7 NEGATIVE 'REYNOLDS'	4. ;		
	1.D4	0.02				
	1.D6	0.04 ;				
SINGULAR	CHANNEL POINT p5 POSITIVE	SINGLAW	NEGATIVE	SINGLAW ;		

## 192.2 Singularities of a TEE-branch

Singular head losses due to a change in flow direction are taken into account in momentum equations of a T-branch. For example, in a single phase, for a T-branch where the flow is exiting, the pressure difference between the internal scalar point  $O_1$  and the junction of the T-branch  $O_3$  will be:  $[\Delta P = P_{O_1} - P_{O_3} = \frac{1}{2}\rho \times V_{O_3}^2]$ .

The kinetic energy of the fluid in the main branch is assumed to be lost.

The user can add further singularities to the model by means of the **SINGULAR** directive. These singularities can depend on the Reynolds number.

## Syntax

<b>SINGULAR</b>	brname	juncti		
<b>IN</b>	Zp	or		lawp
<b>OUT</b>	zm	or		lawm ;

<b>brname</b>	: Tee-branch name.
<b>juncti</b>	: junction name
<b>IN zp</b>	: keyword followed by a real number defining the singularity coefficient for an incoming velocity.
<b>or</b>	
<b>lawp</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW 'REYNOLDS' 'KSING')
<b>OUT zm</b>	: keyword followed by a real number defining the singularity coefficient for an outgoing velocity.
<b>or</b>	
<b>lawm</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW 'REYNOLDS' 'KSING')

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 564/851

## 192.3 Singularities of a 0-D element

Head loss coefficients for a volume element are given junction by junction. These coefficients will be used in the following way to calculate the singular head loss per phase, for incoming or outgoing velocities:  $\Delta P_{sing_k} = 0.5 \times K_{IN} \times \alpha_k \times \rho_k \times V_k \times V_k$  with  $K_{IN}$  the head loss coefficient for an incoming velocity and  $\Delta P_{sing_k} = 0.5 \times K_{OUT} \times \alpha_k \times \rho_k \times V_k \times V_k$  with  $K_{OUT}$  the head loss coefficient for an incoming velocity.

### Syntax

<b>SINGULAR</b>	<b>elem</b>	<b>juncti</b>	<b>IN</b>	<b>xin</b>	<b>OUT</b>	<b>xout</b>
			<b>or</b>	<b>lawin</b>		
		<b>junctj</b>	...			
			...			

<b>elem</b>	: VOLUME element.
<b>juncti</b>	: junction which must be one of the junctions of the element.
<b>IN xin</b>	: keyword followed by a real number defining the head loss coefficient for an incoming velocity.
<b>or</b>	
<b>lawin</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW 'REYNOLDS' 'KSING')
<b>OUT xout</b>	: keyword followed by a real number defining the head loss coefficient for an outgoing velocity.
<b>or</b>	
<b>lawout</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW 'REYNOLDS' 'KSING')

### N.B :

1. If the SINGULAR directive is not used, the default values of Xin and Xout are: Xin = 1. and Xout = 0.
2. Each time SINGULAR directive is used, head loss existing values are replaced by the newly defined ones.

### Remarks :

- When using **Xin = 1**, the entire kinetic energy of the incoming flow is assumed to be lost at the abrupt area change at the inlet of the volume. Pressure inside the volume will then be equal to the pressure at the inlet of the volume, because the velocity-pressure conversion is equal to singular pressure drop. This is well suited for the connection of pipes to large capacities.
- When using **Xin < 1**, the user assumes that his particular geometry requires lower pressure drops than that of the case of an abrupt area change described above. It may happen when the connection from the adjacent element to the VOLUME is very smooth, with continuous orientation from an AXIAL to a VOLUME, close values of hydraulic diameters or other recommendations from the Idel' Cick memento. In that case, the pressure inside the volume (at the junction elevation) appears to be greater than that at the inlet of the volume. It is simply due to the combined effects of the velocity-pressure conversion and low singular pressure drops.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 565/851</a>

- When using **Xin > 1**, the user assumes that his particular geometry requires higher pressure drops than that of the case of an abrupt area change described above. It may happen when the connection from the adjacent element to the VOLUME includes additional effects to that of the simple abrupt area change (complex geometry, grids or structures etc) or other recommendations from the Ide' Cick memento. In that case, the pressure inside the volume (at the junction elevation) appears to be lower than that at the inlet of the volume. It is simply due to the combined effects of the velocity-pressure conversion and high singular pressure drops.
- When using **Xout = 0**, the outlet of the volume is assumed to be smooth enough to consider there is no singular pressure drop.
- When using **Xout > 0**, the user assumes that his particular geometry requires a head loss coefficient.

## 192.4 Singularities of a 3-D element element

This directive of the *data block* imposes singular pressure drops in a three element after the compulsory operators (**MESH**, **GEOM**, **CONNECT** and **PHYSICAL**), the element.

### Syntax

<b>SINGULAR</b> <b>PLOSS</b>	elem <b>POSITIVE</b> <b>X</b> <b>DEFAULT</b> ploss	(or <b>TETA</b> )	
			<b>SEGMENT</b> begpt      endpt <b>VALUE</b> ploss
or	<b>LISTPOINT</b>	npt <b>VALUE</b> pt1 ...	ploss ptnpt
or	<b>FXZONE</b>	vx_zone ibeg iend	
or	<b>FXZONE</b>	jbeg jend kbeg kend	ploss
			<b>SEGMENT</b> begpt      endpt <b>VALUE</b> ploss
	<b>LISTPOINT</b>	npt <b>VALUE</b> pt1 ...	ploss ptnpt
	<b>FYZONE</b>	vy_zone ibeg iend	ploss
	<b>FYZONE</b>		
<b>PLOSS</b>	<b>POSITIVE</b> <b>Y</b> <b>DEFAULT</b> ploss	(or <b>R</b> )	
			<b>SEGMENT</b> begpt      endpt <b>VALUE</b> ploss
or	<b>LISTPOINT</b>	npt <b>VALUE</b> pt1 ...	ploss ptnpt
or	<b>FYZONE</b>	vy_zone ibeg iend	ploss
or	<b>FYZONE</b>		

	<p style="text-align: center;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 566/851

jbeg jend  
kbeg kend      ploss

||

<b>PLOSS</b>	<b>POSITIVE DEFAULT</b>	<b>Z</b> ploss		
or	<b>SEGMENT</b>	begpt	endpt	
	<b>LISTPOINT</b>	npt	ploss	<b>To be repeated as many times as needed</b>
or	<b>FXZONE</b>	<b>VALUE</b>	ploss	
or	<b>FXZONE</b>	pt1	...	
		vz_zone	ploss	
		ibeg iend		
		jbeg jend		
		kbeg kend	ploss	
<b>PLOSS</b>	<b>NEGATIVE DEFAULT</b>	<b>X</b> ploss	(or	<b>TETA)</b>
or	<b>SEGMENT</b>	begpt	endpt	
	<b>LISTPOINT</b>	npt	ploss	<b>To be repeated as many times as needed</b>
or	<b>FXZONE</b>	<b>VALUE</b>	ploss	
or	<b>FXZONE</b>	pt1	...	
		vx_zone	ploss	
		ibeg iend		
		jbeg jend		
		kbeg kend	ploss	
<b>PLOSS</b>	<b>NEGATIVE DEFAULT</b>	<b>Y</b> ploss	(or	<b>R)</b>
or	<b>SEGMENT</b>	begpt	endpt	
	<b>LISTPOINT</b>	npt	ploss	<b>To be repeated as many times as needed</b>
or	<b>FYZONE</b>	<b>VALUE</b>	ploss	
or	<b>FYZONE</b>	pt1	...	
		vy_zone	ploss	
		ibeg iend		
		jbeg jend		

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 567/851

kbeg kend      ploss      ||

**PLOSS**      **NEGATIVE DEFAULT**      **Z**  
     ploss

or	<b>SEGMENT</b>	begpt	endpt	<b>To be repeated as many times as needed</b>
	<b>LISTPOIN</b>	VALUE npt	ploss	
or	<b>FZZONE</b>	VALUE pt1	ploss	... ptntp
or	<b>FZZONE</b>	vz_zone ibeg iend	ploss	
		jbeg jend		
		kbeg kend	ploss	

**elem** : threed element name

**PLOSS** : keyword introducing the head loss coefficient in every direction. It has to be repeated for both every direction X, Y or Z and every flow direction POSITIVE/NEGATIVE. **POSITIVE and NEGATIVE keywords refer to 3D absolute vector numbering** (refer to user manuel appendix about THREED numbering for schematic information on this point).

**POSITIVE** : keyword indicating that the following head loss coefficients are those for the flow going in the meshing direction.

**NEGATIVE** : keyword indicating that the following head loss coefficients are those for the flow going in the opposite direction of the meshing numbering.

#### Rectangular coefficients :

**X** : keyword indicating the X direction.  
**Y** : keyword indicating the Y direction.  
**Z** : keyword indicating the Z direction.

#### Cylindrical coordinates :

**TETA** : keyword indicating the TETA direction.  
**R** : keyword indicating the R direction.  
**Z** : keyword indicating the Z direction.

**DEFAULT** ploss : keyword followed by a real number >0. equal to the head loss coefficient value in the corresponding direction. This head loss coefficient is the same for all the mesh cell.

*If it is necessary, this can be followed by SEGMENT, LISTPOIN and/or FXZONE (FYZONE or FZZONE), repeated as many time as needed.*

**SEGMENT** : keyword to indicate that, for all the mesh cell numbers (face) between begpt and endpt (referring to vector node numbering), the head loss coefficient value is taken equal to the VALUE ploss.

	<p style="margin: 0;">DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
<b>Document technique DEN</b>	<a href="#">Page 568/851</a>

<p><b>begpt</b></p> <p><b>endpt</b></p> <p><b>VALUE ploss</b></p> <p><b>LISTPOIN</b></p> <p><b>npt</b></p> <p><b>VALUE ploss</b></p> <p><b>Pt1 ... ptn</b></p> <p>Or</p> <p><b>FXZONE</b></p> <p><b>FYZONE</b></p> <p><b>FZZONE</b></p> <p><b>v_zone</b></p> <p><b>Ibeg iend</b></p> <p><b>jbeg jend</b></p> <p><b>kbeg kend</b></p> <p><b>ploss</b></p>	<p>: number of the first mesh cell face to be considered.</p> <p>: number of the last mesh cell face to be considered. Then all the mesh cell numbers between begpt and endpt are taken into account.</p> <p>: keyword followed by a real number <math>&gt;0</math> equal to the head loss coefficient value in the corresponding direction.</p> <p>: keyword to indicate that, for a certain number of mesh cells (face) (referring to vector node numbering), the head loss coefficient value is taken equal to the VALUE ploss.</p> <p>: Integer defining the number of mesh cells face taken into account.</p> <p>: keyword followed by a real number equal to the head loss coefficient value in the corresponding direction.</p> <p>: values of the mesh cells face numbers (referring to the vector node numbering in the selected direction) taken into account.</p> <p>: Keyword indicating that all the X vector (Y vector or Z vector) nodes of a rectangular zone have the same singular pressure loss. This option may be repeated as many times as needed. It is followed by :</p> <p>: Name of a zone of X vector (Y vector or Z vector) nodes previously defined in the MESH directive for the elem element.</p> <p>: 6 integers for velocity plane numbers for node zone boundary definition (referring to vector zone numbering).</p> <p>: Real <math>&gt; 0</math>. equal to the singular pressure loss for the considered nodes</p>
--	---

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 569/851</a>

193

## SINGUMOD DIRECTIVE

The **SINGUMOD** directive, in the *command block*, enables the user to modify the law used to calculate the singular pressure drop coefficients as a function of a list of Reynolds numbers. It becomes effective when called and may be used several times during a computation.

### 193.1 Modification of singularities of a 1-D element

#### Associated Keywords

**SINGULAR, LAW**

#### Syntax

<b>SINGUMOD</b>	<code>axial1</code>	<code>iv</code>	<b>POSITIVE</b>	<b>REALLIST</b>	<code>list1</code>
		<code>or</code>	<b>NEGATIVE</b>	<b>REALLIST</b>	<code>list2 ;</code>

<b>axial1</b>	: name of an axial element
<b>iv</b>	: integer specifying the vector point where the singular pressure drop coefficient will be modified
<b>POSITIVE,</b>	: keywords to introduce the values in the direction of positive velocities or in the direction of negative velocities. Positive meaning that the fluid flows from the first mesh to the last mesh of the pipe.
<b>NEGATIVE</b>	
<b>REALLIST list1</b>	: list of Reynolds number values (s).
<b>REALLIST list2</b>	: list of singular pressure drop coefficients

#### Example

<code>SINGUMOD</code>	<code>pipe1</code>	<code>10</code>
-----------------------	--------------------	-----------------

<code>POSITIVE</code>		
-----------------------	--	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 570/851

REALLIST	REALLIST	1.D5	1.D8
IV1	REALLIST	0.5	0.4 ;
SINGUMOD	= VECTOR	pipe1	2. ;
	pipe1	IV1	POSITIVE
	REALLIST	1.D5	1.D8
	REALLIST	0.5	0.4 ;

## 193.2 Modification of singularities of a 0-D element

### Associated Keywords

SINGULAR, LAW

### Syntax

SINGUMOD	volume1	junction1	IN	REALLIST	list1
		or	OUT	REALLIST	list2 ;

<b>volume1</b>	: name of a volume element
junction1	: name of junction where the singular pressure drop coefficient will be modified
<b>IN xin</b>	: keyword followed by a real number defining the head loss coefficient for an incoming velocity.
<b>or</b>	
<b>lawin</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW ‘REYNOLDS’ ‘KSING’)
<b>OUT xout</b>	: keyword followed by a real number defining the head loss coefficient for an outgoing velocity.
<b>or</b>	
<b>lawout</b>	: law defining the singular pressure drop coefficient variation as a function of Reynolds number (LAW ‘REYNOLDS’ ‘KSING’)
<b>REALLIST list1</b>	: list of Reynolds number values (s).
<b>REALLIST list2</b>	: list of singular pressure drop coefficients.

### Example

SINGUMOD	plenum	jcore	IN
	REALLIST	1.D5	1.D8
	REALLIST	0.5	0.4 ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 571/851

**N.B** : the FORTRAN subroutine called in PILOT is SINGUMOD:

CALL SINGUMOD (OBJNAM,CJNAM,NIVAL,NLONG,IVAL ,RVAL, \*9999)

OBJNAM	CHARACTER*8, name of the axial or volume element
CJNAM	CHARACTER*8, name of the junction of the volume
NIVAL	INTEGER, size of IVAL array
NLONG	INTEGER, number of singular pressure drop values in REALLIST
IVAL(NIVAL)	INTEGER array of : vector point number, IN/OUT or POSITIVE/NEGATIVE values
RVAL(NLONG*2+1)	DOUBLE PRECISION array of : first the REALLIST values of the Reynolds number and then the REALLIST values of the singular pressure drop coefficient

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 572/851

# 194

## SINK OPERATOR

The **SINK** operator creates in *data block* a SINK submodule by defining its characteristics. Any required number of sinks can be defined in **CATHARE**, but 200 is the maximum supported by the reader (standard installation, [2]). A sink will be defined on an AXIAL or VOLUME element. The SINK operator only defines and locates the sink and **does not open the sink** (see **ENABLE**, **DISABLE**).

A sink corresponds to a removal of fluid or a leak in an element. There are four kinds of sinks:

1. **INTERNAL SINK** : the sink is automatically and internally controlled by the computation. In order to act on the sink, a law has to be given by the user.
2. **EXTERNAL SINK**: the user controls the sink within the executable block of the data set using the Cathare computation variables (CCV). It is called external since it is managed from outside of the code. Effective CCV : TOTFLOW
3. **SAFETY-VALVE SINK** : the flowrate of the sink is the product of the sonic flow and the cross section aperture defined with the calibration pressure, the deltap at maximum opening and the cross section at maximum opening.
4. **SINK** with a PURGE option

### Associated Keywords

**ENABLE**, **DISABLE**, **OPENALL**, **WRITE FOR A SINK**, **VALUE FOR A SINK**, **VALBA FOR A SINK**, **WRITE FOR A SINK**

## 194.1 SINK on a 1-D element

A sink has to be defined on a scalar point of the element.

### Syntax

<b>S1 =SINK</b>	<b>AXIAL</b>	<b>elem</b>				
	<b>INTERNAL</b>	<b>loisi</b>	<b>ip</b>	<b>SECT</b>	<b>s ;</b>	
	<b>or</b>					
	<b>EXTERNAL</b>		<b>ip</b>	<b>SECT</b>	<b>s ;</b>	

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 573/851</a>

**elem** : axial element name  
**INTERNAL loisi** : keyword to indicate that the sink is an internal sink followed by the name of the law giving the flowrate variations as a function of the pressure.  
**EXTERNAL** : keyword to indicate that the sink is an external sink. The flowrate values will be imposed by the [CCV TOTFLOW](#) (see [WRITE FOR A SINK](#)), with a computation stop if the value exceeds the sonic flow value (if  $Q_{tot} > Q_{sonic}$ ).  
**ip** : scalar point on the axial mesh.  
**SECT s** : keyword followed by a real number  $> 0$ . giving the sink cross-section.( $m^2$ )

### Example

```

lawpui =      LAW      'PRESSURE'   'FLOWRATE'
              10.D5       5.D2
              5.D5       2.D2
P1 =          SINK      AXIAL       coldleg    INTERNAL
              lawpui     IP6        SECT       .2 ;
P2 =          SINK      AXIAL       coldleg    EXTERNAL
              IP6        SECT       .2 ;
  
```

## 194.2 SINK on a 0-D element

For a volume, the definition of a sink is complemented by the notions sink/control valve (valve) and sink/safety valve (safetyva):

1. **For an EXTERNAL sink**, the flow rate of the sink is given by the value of the CCV TOTFLOW with a stop concerning the sonic flow when  $Q_{tot} > Q_{sonic}$ .
2. **For an EXTERNAL VALVE sink**, the flow rate of the sink, given by the product of the sonic flow and the cross-section of the sink aperture, can be defined in the executable block of the data set using the [CCV: VALVSECT](#).
3. **For an EXTERNAL SAFETYVA sink**, the flow rate of the sink will be the product of the sonic flow and the cross-section of the safety valve aperture defined with the calibration pressure, the deltap at maximum opening and the cross-section of maximum opening.
4. **For an INTERNAL sink**, a law has to be defined by the user, giving the flowrate variations as a function of the pressure.

### Syntax

```

S1 =SINK      VOLUME      elem
           INTERNAL    loisi
                           ELEV       elevi
                           SECT       seci ;
  
```

or	<b>EXTERNAL</b>	<b>ELEV</b>	elevi	<b>SECT</b>	seci ;	
or	<b>EXTERNAL</b>	<b>ELEV</b>	elevi	<b>VALVE</b>	<b>SECT</b>	seci ;
or	<b>EXTERNAL</b>	<b>SAFETYV</b>	<b>PRESSURE</b>	pr		
			<b>DELTAP</b>	delta1		
			<b>SECT</b>	seci ;		

<b>elem</b>	: volume element name
<b>INTERNAL loisi</b>	: keyword to indicate that the sink is an internal sink followed by the name of the law giving the flowrate variations as a function of the pressure.
<b>ELEV elevi</b>	: keyword followed by a real number $\geq 0$ . and $\leq \ell$ (height of the volume), which defines the distance between the sink and the bottom of the volume (m).
<b>SECT seci</b>	: keyword followed by a real number $> 0$ . which defines the cross-section of the removal aperture ( $m^2$ ).
<b>or</b>	
<b>EXTERNAL</b>	: keyword to indicate that the sink is an external sink. The flowrate values are imposed by the <b>CCV TOTFLOW</b> .
<b>ELEV elevi</b>	: keyword followed by a real number $\geq 0$ . and $\leq \ell$ (height of the volume), which defines the distance between the sink and the bottom of the volume (m).
<b>SECT seci</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the sink ( $m^2$ ).
<b>or</b>	
<b>VALVE</b>	: keyword to indicate that the sink-control valve notion is to be used. The flowrate values are calculated with the sonic flow calculation result and the section given by the <b>CCV VALVSECT</b> . This is followed by :
<b>SECT seci</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the control valve opening ( $m^2$ ).
<b>or</b>	
<b>SAFETYVA:</b>	: keyword to indicate that the sink-safety valve notion is to be used. This is followed by :
<b>PRESSURE pres1</b>	: keyword followed by a real number $> 0$ . defining the calibration pressure of the safety valve (Pa).
<b>DELTAP delta1</b>	: keyword followed by a real number defining the pressure difference with respect to the maximum opening of the safety valve (Pa). This value should never be equal to 0.D0 ( $10^3$ is a minimum advised value).
<b>SECT seci</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the maximum opening of the safety valve ( $m^2$ ).

---

## Example

SS1 = SINK      VOLUME      violin      INTERNAL  
                   loisi      ELEV      0.2      SECT      0.888 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 575/851

```

S2 =SINK      VOLUME      volinf      EXTERNAL
ELEV          0.2          SECT        0.888 ;
S3 = SINK     VOLUME      volinf      EXTERNAL
ELEV          0.2          VALVE      SECT        0.888 ;
S4 = SINK     VOLUME      volinf      EXTERNAL
ELEV          0.2          PRESSURE   50.d5
SAFETYVA    DELTAP       5.d5
                  SECT        0.888;

```

**\* Command Block:**

```

qpuia =      - 100.D0 ;
WRITE        - 0.5          VALVSECT   S3 ;
WRITE        qpuia         TOTFLOW    S3 ;
OPEN         S3 ;

```

### 194.3 SINK with PURGE option for a turbine

This kind of **sink** must be defined on an **axial** element after the location of a **turbine**. It is a liquid sink used to eliminate the potential liquid flow rate appearing after the turbine.

#### Syntax

```

S1 =SINK      AXIAL       elem
                  PURGE      ip
                  PURGEFF   effi ;

```

**elem** : name of the pipe element.  
**PURGE** : keyword to indicate that the sink is a purge,  
**ip** : scalar point on the axial mesh.  
**PURGEFF effi** : keyword followed by a real number  $\geq 0.$  and  $\leq 1.$ , which defines the efficiency of the purge.

#### Example

```

IS10 =        SCALAR      STEAMLIN   10.5 ;
SINK1 =       SINK        AXIAL      STEAMLIN
                  PURGE      IS10
                  PURGEFF   0.9 ;

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 576/851

195

## SINKRRI OPERATOR

The **SINKRRI** operator creates in *data block* a SINK of [CCCW \(RRI\)](#) type by in a **0-Delement**. This operator only defines and locates the sink and does not open it (see directives [ENABLE](#), [DISABLE](#)).

A sink of [CCCW \(RRI\)](#) type or SINKRRI corresponds to a sink in a volume with exchangers. The fluid is removed from the volume and sent to exchangers to be cooled (the flow rate being negative). There may be one, two or three exchangers. There are two kinds of SINKRRI:

1. **INTERNAL SINKRRI** : the sink and the exchangers are automatically and internally controlled by the computation. In order to act on the sink or exchangers, laws must be defined by the user, giving the flowrate variations and the temperature variations as functions of pressure or time.
2. **EXTERNAL SINKRRI**: the user controls the sink and the exchangers within the executable block of the data set using the Cathare computation variables ([CCV](#)). It is called external since it is managed from outside of the code.

### Associated Keywords

[ENABLE](#), [DISABLE](#), [EXHYLINK](#)

### Syntax

## 195.1 1<sup>st</sup> case : The sinkrri contains a CCCW circuit and two or three exchangers

1. a CSS (EAS)/CCCW (RRI) exchanger and possibly a [LPSI/CCCW \(RRI\)](#) exchanger in parallel,
2. a [CCCW \(RRI\)/ESWS \(SEC\)](#) exchanger

S1 =	<b>SINKRRI</b>	<b>VOLUME</b>	elem		
		<b>INTERNAL</b>	or	<b>EXTERNAL</b>	
		<b>ELEV</b>	elevi	<b>SECT</b>	secsi
		<b>TOTFLOW</b>	lawqtot	or	zqtot

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 577/851</a>

EAS	DIRECT <b>KSURF</b>	or kseas	<b>REVERSE</b>	
[ <sup>1</sup> <b>ISBP</b>	<b>XRATEAS</b>	lawxeas	or	zxeas
	<b>DIRECT</b>	or	<b>REVERSE</b>	
	<b>KSURF</b>	ksisbp	] <sup>1</sup>	
<b>RRI</b>	<b>FLOWRRI</b>	lawqrri	or	zqrri
	[ <sup>1</sup> <b>XRRIEAS</b>	xreas] <sup>1</sup>	<b>CPRRI</b>	cp2
	<b>(FLOWAUX</b>	lawqaux	or	zqaux
	<b>POWAUX</b>	lawpaux	or	zpaux)
<b>SEC</b>	<b>DIRECT</b>	or	<b>REVERSE</b>	
	<b>KSURF</b>	ks3		
	<b>FLOWSEC</b>	lawqsec	or	zqsec
	<b>TEMPSEC</b>	lawtsec	or	ztsec
		(CPSEC	cp1 )	

;

<b>elem</b> <b>INTERNAL</b> <b>or</b> <b>EXTERNAL</b>	: VOLUME type element : keyword to indicate that the sinkrri is internal or external.
<b>ELEV elevi</b>	: keyword followed by a real number $\geq 0$ . and $\leq \ell$ (height of the volume), which defines the distance between the sink and the bottom of the volume (m).
<b>SECT seci</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the injection opening ( $m^2$ ). This is followed by :
<b>TOTFLOW</b>	: keyword defining the total flowrate removed from the volume by the sink. It is followed by :
lawqtot	: the name of the law giving the FLOWRATE VARIATIONS as a function of pressure if the sinkrri is internal
or zqtot	: a real number $\leq 0$ defining the flowrate (kg/s) if the sinkrri is external.
<b>EAS</b> <b>DIRECT or</b> <b>REVERSE</b> <b>KSURF kseas</b>	: keyword to indicate the presence of an exchanger <a href="#">CSS (EAS) / CCCW (RRI)</a> . : keyword to indicate that the secondary side of the exchanger has the same or the opposite orientation than the primary side. : keyword followed by a real number $\geq 0$ . defining the product of the exchange coefficient with the total exchange surface of the exchanger (W/ $^{\circ}$ C).
<b>XRATEAS</b>	: OPTIONAL keyword. In case of two parallel exchangers <a href="#">CSS (EAS) / CCCW (RRI)</a> and ISBP/RRI, defining the relative fraction of the total flow removed from the volume flowing to the exchanger <a href="#">CSS (EAS) / CCCW (RRI)</a> . It is followed by :
lawxeas	: the name of the law giving the XRATE variations as a function of time if the sinkrri is internal,
or zxeas	: a real number $\geq 0$ and $\leq 1$ defining the relative fraction if the sinkrri is external, the three following keywords:

<sup>1</sup>[ ] denotes data to be added only in case of an [LPSI / CCCW \(RRI\)](#) exchanger in parallel

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 578/851

<b>ISBP</b> <b>DIRECT or REVERSE</b> <b>KSURF ksispb</b>	: OPTIONAL keyword to indicate the presence of an exchanger <a href="#">LPSI / CCCW (RRI)</a> . This keyword is followed by the two following keywords : : keyword to indicate that the secondary side of the exchanger <a href="#">LPSI / CCCW (RRI)</a> has the same or the opposite orientation than the primary side. : keyword followed by a real number $\geq 0$ . defining the product of the exchange coefficient with the total exchange surface of the exchanger (in W/ $^{\circ}$ C).
<b>RRI</b> <b>FLOWRRI</b>	: keyword to indicate the presence of a circuit <a href="#">CCCW (RRI)</a> . : keyword defining the flowrate in the circuit <a href="#">CCCW (RRI)</a> in the <a href="#">CCCW (RRI) / ESWS (SEC)</a> exchanger. It is followed by :
lawqrri  or zqrri	:the name of the law giving the FLOWRATE variations as a function of time if the sinkrri is internal, a real number $\geq 0$ . defining the flowrate (kg/s) if the sinkrri is external.
<b>XRRIEAS xreas</b>	: keyword followed by a real number $\geq 0$ . and $\leq 1$ . In case of two parallel exchangers <a href="#">CSS (EAS) / CCCW (RRI)</a> and <a href="#">LPSI / CCCW (RRI)</a> , it defines the relative fraction of the flowrate of the circuit <a href="#">CCCW (RRI)</a> flowing through the exchanger <a href="#">CSS (EAS) / CCCW (RRI)</a> .
<b>CPRRI cp2</b>	: keyword followed by a real number $\geq 0$ defining the specific heat (J/kg/ $^{\circ}$ C) of the fluid in the <a href="#">CCCW (RRI)</a> circuit.
<b>FLOWAUX</b>	: OPTIONAL keyword defining the flowrate of the fluid in the <a href="#">CCCW (RRI)</a> circuit flowing in auxiliary circuits (but not in the EAS/ <a href="#">CCCW (RRI)</a> or ISBP/ <a href="#">CCCW (RRI)</a> exchangers). It is followed by :
lawqaux  or zqaux	: the name of the law giving the FLOWRATE variations as a function of time if the sinkrri is internal, : a real number $\geq 0$ . defining the flowrate (kg/s) if the sinkrri is external. This keyword is followed by :
<b>POWAUX</b>	: keyword defining the power removed in auxiliary circuits of the <a href="#">CCCW (RRI)</a> circuit (but not in the <a href="#">CSS (EAS) / CCCW (RRI)</a> or ISBP/RRI exchangers). It is followed by :
lawpaux  or zpaux	: the name of the law giving the POWER variations as a function of pressure if the sinkrri is internal : a real number $\geq 0$ . defining the power (W) if the sinkrri is external.
<b>SEC</b> <b>DIRECT or REVERSE</b> <b>KSURF kssec</b>	: keyword to indicate the presence of an exchanger <a href="#">CCCW (RRI) / ESWS (SEC)</a> . : keyword to indicate that the secondary side of the exchanger has the same or the opposite orientation than the primary side. : keyword followed by a real number $\geq 0$ . defining the product of the exchange coefficient with the total exchange surface of the exchanger.
<b>FLOWSEC</b>	: keyword defining the flowrate in the <a href="#">CCCW (RRI) / ESWS (SEC)</a> exchanger on the SEC side. It is followed by :
lawqsec  or zqsec	: the name of the law giving the FLOWRATE variations as a function of time if the sinkrri is internal, : a real number $\geq 0$ . defining the flowrate (kg/s) if the sinkrri is external.
<b>TEMPSEC</b>	: keyword defining the temperature of the incoming fluid in the <a href="#">CCCW (RRI) / ESWS (SEC)</a> exchanger on the SEC side. It is followed by :
lawtsec	: the name of the law giving the TL variations as a function of time if the sinkrri is internal,

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 579/851

or ztsec	: a real number $\geq 0$ . defining the liquid temperature ( $^{\circ}\text{C}$ ) if the sinkrri is external.
<b>CPSEC cp1</b>	: OPTIONAL keyword followed by a real number $\geq 0$ . defining the specific heat ( $\text{J/kg}/^{\circ}\text{C}$ ) of the fluid in the <a href="#">CCCW (RRI)</a> / <a href="#">ESWS (SEC)</a> exchanger on the SEC side. By default, the specific heat of the fluid in the SEC circuit as the specific heat defined by the keyword CPRRI.

## 195.2 2<sup>nd</sup> case : The sinkrri contains only an CSS/SEB exchanger

S1 =	SINKRRI	<b>VOLUME</b> <b>INTERNAL</b> <b>ELEV</b>	elem or elevi	<b>EXTERNAL</b> <b>SECT</b>	secsi
		<b>TOTFLOW</b>	lawqtot or zq-tot		
	<b>EASSEB</b>	<b>DIRECT</b> <b>KSURF</b> <b>FLOWSEB</b> <b>TEMPSEB</b> <b>CPSEB</b>	or kseb lawqseb lawtseb cp1 ;	<b>REVERSE</b>	zqseb ztseb

<b>elem</b>	: volume element name
<b>INTERNAL</b> <b>or EXTERNAL</b>	: keyword to indicate that the sinkrri is internal or external.
<b>ELEV elevi</b>	: keyword followed by a real number $\geq 0$ and $\leq f$ (height of the container), which defines the distance between the sink and the bottom of the volume (m).
<b>SECT secsi</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the injection opening ( $\text{m}^2$ ). This is followed by :
<b>TOTFLOW</b> lawqtot	: keyword defining the flowrate in the <a href="#">CSS (EAS)</a> /SEB exchanger. It is followed by :
	: the name of the law giving the FLOWRATE variations as a function of pressure if the sinkrri is internal,
or zqtot	: a real number $\leq 0$ . defining the flowrate (kg/s) if the sinkrri is external.
<b>EASSEB</b>	: keyword to indicate the presence of an exchanger <a href="#">CSS (EAS)</a> /SEB.
<b>DIRECT or</b>	: keyword to indicate that the secondary side of the exchanger has the same or the opposite orientation than primary side.
<b>KSURF kseb</b>	: keyword followed by a real number $\geq 0$ . defining the product of the exchange coefficient with the total exchange surface of the exchanger ( $\text{W}/^{\circ}\text{C}$ ).
<b>FLOWSEB</b>	: keyword defining the flowrate in the <a href="#">CSS (EAS)</a> /SEB exchanger on the SEB side. It is followed by :
Lawqseb	: the name of the law giving the FLOWRATE variations as a function of time if the sinkrri is internal,
or zqseb	: a real number $\geq 0$ . defining the flowrate (kg/s) if the sinkrri is external.

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 580/851

- TEMPSEB** : keyword defining the temperature of the incoming fluid in the **CSS (EAS)/SEB** exchanger on the SEB side. It is followed by :
- lawtseb** : the name of the law giving the TL variations as a function of time if the sinkrri is internal,
- or ztseb** : a real number  $\geq 0$ . defining the liquid temperature ( $^{\circ}\text{C}$ ) if the sinkrri is external.
- CPSEB cp1** : keyword followed by a real number  $\geq 0$ . defining the specific heat ( $\text{J/kg}/^{\circ}\text{C}$ ) of the fluid in the **CSS (EAS)/SEB** exchanger on the SEB side.

### Example

```
S1 =      SINKRRI    VOLUME    volinf    EXTERNAL
          ELEV        0.1D0     SECT       1.D0
          TOTFLOW   -400.D0
          EAS         DIRECT    KSURF      2.D6
          XRATEAS   0.5D0     ISBP       REVERSE    KSURF      1.D6
          RRI         FLOWRRI  610.D0   XRRIEAS   0.4D0
          CPRRI      4.18 D3
          FLOWAUX   10.D0    POWAUX     83.D3
          SEC         REVERSE   KSURF      3.D6
          FLOWSEC   580.D0   TEMPSEC    18.D0
          CPSEC      4.D3 ;
```

#### Example of 1-st case with laws

```
lawqtot =      LAW      'PRESSURE'  'FLOWRATE'
               1.D5      -400.D0
               2.D5      -350.D0
               4.D5      -300.D0
               150.D5    0.D0 ;
lawqrri =      LAW      'ABSTIME'   'FLOWRATE'
               0.D0      600.D0
               1.D5      500.D0 ;
lawqsec=      LAW      'ABSTIME'   'FLOWRATE'
               0.D0      300.D0
               1.D5      600.D0 ;
lawtsec=      LAW      'ABSTIME'   'TL'
               0.D0      10.D0
               1.D5      20.D0 ;
lawqaux=      LAW      'ABSTIME'   'FLOWRATE'
               0.D0      10.D0
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 581/851

		1.D5	15.D0 ;				
lawpaux=	LAW	'ABSTIME'	'POWER'				
		0.D0	50.D3				
		1.D5	60.D3 ;				
S2 =	SINKRRI	VOLUME	volinf	INTERNAL			
			ELEV	0.1D0	SECT		1.D0
			LENGTH	0.D0			
		TOTFLOW	lawqtot				
	EAS	REVERSE	KSURF	1.74D6			
	RRI	FLOWRRI	lawqrri	CPRRI		4.18D3	
		FLOWAUX	lawqaux	POWAUX		lawpaux	
	SEC	REVERSE	KSURF	2.D6			
		FLOWSEC	lawqsec	TEMPSEC		lawtsec ;	

#### Example of 2-nd case with laws

lawqtot =	LAW	'PRESSURE'	'FLOWRATE'				
		1.D5	400.D0				
		2.D5	350.D0				
		4.D5	300.D0				
		150.D5	0.D0 ;				
lawqseb=	LAW	'ABSTIME'	'FLOWRATE'				
		0.D0	300.D0				
		1.D5	600.D0 ;				
lawtseb=	LAW	'ABSTIME'	'TL'				
		0.D0	10.D0				
		1.D5	20.D0 ;				
S3 =	SINKRRI	VOLUME	volinf	INTERNAL			
			ELEV	0.1D0	SECT		1.D0
		TOTFLOW	lawqtot				
	EASSEB	DIRECT	KSURF	3.D6			
		FLOWSEB	lawqseb	TEMPSEB		lawtseb	
		CPSEB	4.18 ;				

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 582/851

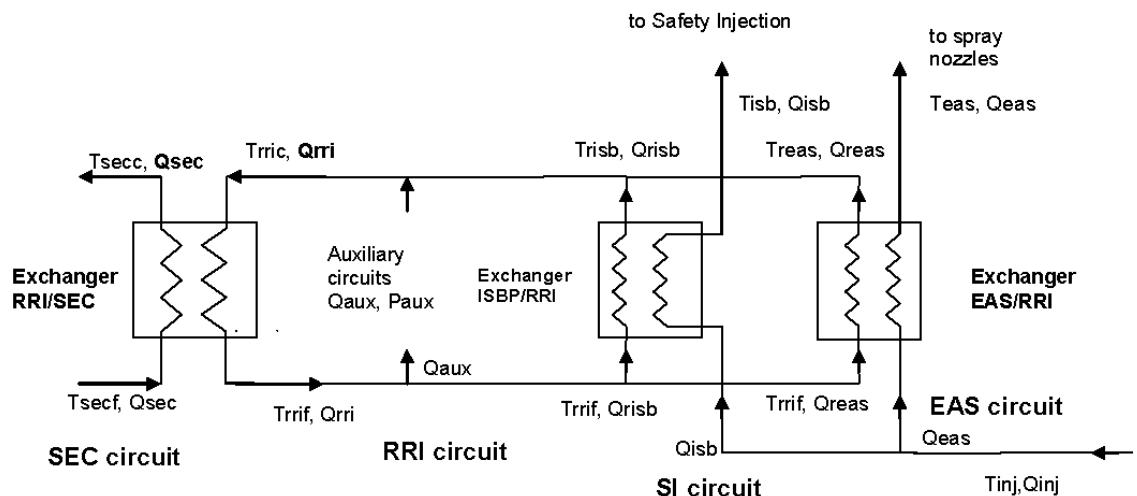


Figure 195.1.1: SINKRRI : modeling scheme for the 1<sup>st</sup> case

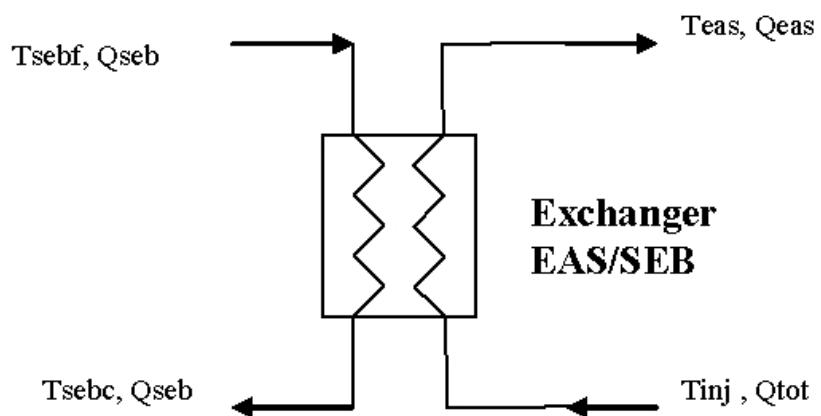


Figure 195.2.1: SINKRRI : modeling scheme for the 2<sup>st</sup> case

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 583/851

# 196

## SOURCEMOD DIRECTIVE

This directive is used to modify laws of an **internal** source, in *command block*.

### Associated Keywords

#### SOURCE

### Syntax

<b>SOURCEMOD</b>  <b>LIQUID</b> <b>VARI</b>  <b>or</b> <b>STEAM</b> or <b>NONCOND2</b> or ... <b>PRESSURE</b> <b>REALIST</b> <b>FLOWRATE</b>	sourcename  <b>PRESSURE</b> or <b>ABSTIME</b> <b>REALIST</b> yi... <b>FLOWRATE</b> <b>REALIST</b> xi      ...  <b>PRESSURE</b> or <b>ABSTIME</b> <b>REALIST</b> yi      ... <b>VARI</b> <b>REALIST</b> xi      ...  <b>NONCOND1</b>  <b>NONCOND4</b> <b>PRESSURE</b> or <b>ABSTIME</b> <b>REALIST</b> yi... <b>FLOWRATE</b> <b>REALIST</b> xi      ...  <b>VARI</b> <b>PRESSURE</b> <b>REALIST</b> <b>VARI</b>
---	--

**sourcename**      name of the source.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 584/851</a>

<b>LIQUID</b> <b>PRESSURE</b> <b>REALLIST yi ...</b> <b>Or</b> <b>ABSTIME</b> <b>REALLIST yi ...</b>  <b>FLOWRATE</b>  <b>VARI</b>	<p>: keyword to indicate that the source is a liquid source. For a steam source the keyword <b>STEAM</b> will be used. For the 1<sup>st</sup> noncondensable the keyword <b>NONCOND1</b> will be used, <b>NONCOND2</b> for the 2<sup>nd</sup> etc ...  It is followed by :</p> <p>: keyword defining the change in flow rate as a function of pressure, followed by :  : keyword followed by a list of real numbers giving pressure values.</p> <p>: keyword defining the change in flow rate as a function of time, followed by :  : keyword followed by a list of real numbers giving time values.</p> <p>: keyword followed by a list of real numbers giving flowrate values.</p> <p>: Name of the variable</p> <p><u>for a liquid source :</u>  <b>HL TL UNDERSAT</b> or <b>UNDERSPV</b> with :  HL : liquid enthalpy (J/kg)  TL : liquid temperature (°C)  UNDERSAT : difference in liquid sub-saturation temperature in relation to P :  <math>T_{sat}(P) - T_L</math>, (°C)  UNDERSPV : difference in liquid sub-saturation temperature in relation to PV :  <math>T_{sat}(PV) - T_L</math> TSAT(PV), (°C)</p> <p><u>for a steam (or NONCOND) source :</u>  <b>HG TG OVERHEAT</b> or <b>OVERHEPV</b> with :  HG : gas enthalpy (J/kg)  TG : gas temperature (°C)  OVERHEAT : difference in gas overheating temperature in relation to P : <math>T_G - T_{sat}(P)</math>, (°C)  OVERHEPV : difference in gas overheating temperature in relation to PV :  <math>T_G - T_{sat}(PV)</math>, (°C)</p> <p><b>PRESSURE</b>  <b>REALLIST yi ...</b>  <b>Or</b>  <b>ABSTIME</b>  <b>REALLIST yi ...</b>  <b>VARI</b></p>
---	---

### Example

#### In the data block

LAWTL = LAW

'ABSTIME'	'TL'
0.0D0	138.D0
2000.0D0	138.D0 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 585/851

LAWINJ        = LAW  
                    ‘ABSTIME’     ‘FLOWRATE’  
                    0.0D0            0.D0  
                    89.749D0        0.D0 ;

**\*INJECTION definition**

INJ =	SOURCE	AXIAL	UPVOL	INTERNAL	PINJ	
	ELEV	0.5D0	SECT	12.0D-6	ANGLE	3.142D0
	INJECLAW	LIQUID	LAWINJ			
		TL	LAWTL			

**\*In the command block**

SOURCEMOD	INJ	
LIQUID		
ABSTIME	REALLIST	20.
FLOWRATE	REALLIST	15.D-3
TL		520.
ABSTIME	REALLIST	20.
TL	REALLIST	138.D0
		138.D0 ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 586/851

197

## SOURCE OPERATOR

The **SOURCE** operator creates, in *data block*, a SOURCE by defining its characteristics. Up to 200 SOURCE objects can be supported by the reader (in standard installation, [2]). A source can be defined on an AXIAL or VOLUME element. The SOURCE operator only defines and locates a source and does not open it (see **ENABLE**, **DISABLE**).

A source describes the injection of liquid or gas, non condensable gas or **radio-chemical component** into the element. Two types of injection can be defined: External and internal SOURCE

### 1. EXTERNAL SOURCE

- (a) Injection is controlled by the user in the *command block* of the data set, using **CCV**.
- (b) The **CCV** data set must be defined before the **ENABLE** directive.
- (c) The source can be monophasic or diphasic.
- (d) In case of noncondensable source, i represents the number of the noncondensble gas.
- (e) The default value for SLIPRATE is 1. ( $SLIPRATE = \frac{V_G}{V_L}$ ).
- (f) Depending on the injection type of the source, the **CCV** data to set are the following :

<u>liquid</u>	⇒	WRITE LIQFLOW
	and	HЛИQEXT or TLIQEXT or UNDERSAT or UNDERSPV
<u>steam</u>	⇒	WRITE STMFLOW
	and	HГASEXT or TGASEXT or OVERHEAT or OVERHEPV
<u>noncond</u>	⇒	WRITE XiFLOW
	and	HГASEXT or TGASEXT or OVERHEAT or OVERHEPV
<u>diphasic</u>	⇒	<i>Case of DIPHTOTA type sources</i> WRITE TOTFLOW, ALFAEXT, SLIPRATE, XiEXT
	and	HГASEXT or TGASEXT or OVERHEAT or OVERHEPV
	and	HЛИQEXT or TLIQEXT or UNDERSAT or UNDERSPV
	⇒	<i>Case of DIPHALFA type sources</i> WRITE GASFLOW, LIQFLOW, ALFAEXT, XiEXT
	and	HГASEXT or TGASEXT or OVERHEAT or OVERHEPV
	and	HЛИQEXT or TLIQEXT or UNDERSAT or UNDERSPV
	⇒	<i>Case of DIPHGAMA type sources</i> WRITE GASFLOW, LIQFLOW, SLIPRATE, XiEXT
	and	HГASEXT or TGASEXT or OVERHEAT or OVERHEPV

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 587/851

and      HLIQEXT or TLIQEXT or UNDERSAT or UNDERSPV

⇒      *Case of PFM, VFM type sources*  
 WRITE TOTFLOW, ENTHFLOW, XiFLOW

**2. INTERNAL SOURCE :** The injection is automatically controlled within the computation. The control is made by one of the following ways:

- (a) by using the evolution of the flow rate, stored into a private library (keyword CP1)
- (b) by giving an evolution law when the source is defined, covering the evolution of in the flow rate of the liquid or the gas as a function of pressure or time ; the source control is then carried out automatically with time (INJECLAW, TWOPHASE or SATURATE).

#### Associated Keywords

**ENABLE, DISABLE, SOURCEMOD, OPENALL, WRITE FOR A SOURCE, VALUE FOR A SOURCE, VALBA FOR A SOURCE, WRIBA FOR A SOURCE, WRITE FOR A SOURCE**

#### Syntax

<b>type-elem</b> <b>elem</b> <b>INTERNAL</b> <b>ip</b> <b>ELEV elevi</b>  <b>ELEV 0.</b> <b>ELEV 1</b> <b>ELEV 0.5</b>	: keyword AXIAL or VOLUME : axial or volume type element name : keyword to indicate that the source is an internal source. For an external source, the keyword <b>INTERNAL</b> will be replaced by the keyword <b>EXTERNAL</b> . : scalar point of the meshing of the axial element. It should not be mentioned for a source in a volume element. : keyword followed by a real number. For an <b>axial</b> element this number defines the standardized position of the source injection point with respect to the bottom of the pipe and must be $\geq 0$ . and $\leq 1$ . Examples : Injection under the pipe injection on the pipe lateral injection half way up the pipe.
	For a <b>volume</b> element this number defines the elevation of the source with respect to the bottom of the volume and must be $\geq 0$ . and $\leq \ell$ (height of the volume).
<b>SECT seci</b> <b>ANGLE alpha</b>  <b>or</b> <b>PERPENDI</b> <b>LENGTH longi</b>	: keyword followed by a real number $> 0$ . defining the cross-section of the injection opening ( $m^2$ ). For an <b>axial</b> element, this is followed by : : keyword followed by a real number defining the angle between the direction of injection and the mesh of the element (rad). This data should not be mentioned for a source in a <b>volume</b> element.  : If the injection is perpendicular to the mesh of the element. This data should not be mentioned for a source in a <b>volume</b> element. : keyword followed by a real number $\geq 0$ defining the source penetration length in the <b>volume</b> . This data should not be mentioned for a source in an <b>axial</b> element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 588/851

## 197.1 External source

S1 =      **SOURCE**      type-elem      elem      **EXTERNAL**

<b>ip</b>	elem (if axial)	<b>ELEV</b>	elevi	<b>SECT</b>	seci
		<b>ANGLE</b>	alpha		<b>PERPENDI</b>
		or			(if axial)
		<b>LENGTH</b>	longi		(if volume)
		<b>(VFM</b>	or	<b>PFM</b>	or
		<b>DIPHTOTA</b>	or	<b>DIPHALFA</b>	or
		<b>DIPHGAMA</b>	or	<b>LIQUID</b>	or
		<b>STEAM</b>	or	<b>NONCOND<i>i</i></b>	
				)	

A keyword to indicate the kind of injection for the source. The models of distribution of the fluid at the source are:

**LIQUID**  
or **STEAM**  
or **NONCOND*i*** : Monophasic kinds of injection models are liquid (LIQUID), steam (STEAM) or non condensable gaz number *i* ( $1 \leq i \leq 4$ ) (NONCOND*i*).

or **DIPHTOTA**  
or **DIPHALFA**  
or **DIPHGAMA** : source type based on total flowrate, void fraction, slip rate, liquid and gas enthalpies.  
: source type based on liquid and gas flowrates, void fraction, liquid and gas enthalpies.  
: source type based on liquid and gas flowrates, slip rate liquid and gas enthalpies.

or **VFM**  
or **PFM** The following models are used for containment volume calculation :  
: mixture before separation (based on total flowrate and enthalpy flowrate)  
: separation before mixture (based on total flowrate and enthalpy flowrate)

These models can be used if there are non condensable gases in the element. VCC names to use are specified at the beginning of SOURCE operator paragraph. Default value is DIPHGAMA.

## 197.2 Internal source

S1 =      **SOURCE**      type-elem      elem      **INTERNAL**

<b>ip</b> (if axial)	elem	<b>ELEV</b>	elevi	<b>SECT</b>	seci
		<b>ANGLE</b>	alpha		<b>PERPENDI</b>
		or			(if axial)
		<b>LENGTH</b>	longi		(if volume)
<b>CP1</b>					
or					

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 589/851

<b>INJECLAW</b>	<b>LIQUID</b>	lawj	VARI	lawtja
	or			
	<b>STEAM</b>	lawj	VARI	lawtja
	or			
	<b>NONCOND1</b>	lawj	VARI	lawtja
	or			
	<b>NONCOND2</b>	lawj	VARI	lawtja
	or			
	<b>NONCOND3</b>	lawj	VARI	lawtja
	or			
	<b>NONCOND4</b>	lawj	VARI	lawtja
	( <b>COMPONENT</b> name		<b>LIQPHASE</b>	lawl
			or	
			<b>GASPHASE</b>	lawg )
	or			
<b>SATURATE</b>	<b>PFM</b>	or	<b>VFM</b>	
	<b>TOTFLOW</b>	lawj		
	<b>ENTHFLOW</b>	lawj		
	<b>X1FLOW</b>	lawj		
	...			
	<b>X4FLOW</b>	lawj		
	( <b>COMPONENT</b> name		<b>LIQPHASE</b>	lawl
			or	
			<b>GASPHASE</b>	lawg ) ;
	or			
<b>TWOPHASE</b>	<b>LIQFLOW</b>	lawfl	<b>GASFLOW</b>	lawfg
	<b>VARL</b>		<b>REALIST</b>	listL
	<b>VARG</b>		<b>REALIST</b>	listG
	<b>ALFA</b>		<b>REALIST</b>	listAL
	<b>Xi</b>		<b>REALIST</b>	listXi
	<b>LIQFRXi</b>		<b>REALIST</b>	listRLi
	<b>GASFRXi</b>		<b>REALIST</b>	listRGi
	<b>ABSTIME</b>		<b>REALIST</b>	listt
	or			
	<b>TOTFLOW</b>	lawf		
	<b>VARL</b>		<b>REALIST</b>	listL
	<b>VARG</b>		<b>REALIST</b>	listG
	<b>ALFA</b>		<b>REALIST</b>	listAL
	<b>GAMMA</b>		<b>REALIST</b>	listGA
	<b>Xi</b>		<b>REALIST</b>	listXi
	<b>LIQFRXi</b>		<b>REALIST</b>	listRLi
	<b>GASFRXi</b>		<b>REALIST</b>	listRGi
	<b>ABSTIME</b>		<b>REALIST</b>	Listt;

Four possibilities are available:

1. First possibility: the user wants to use the HPIS law for a CP1 PWR reactor defined in a library.

**CP1** : keyword indicating that the CP1 HPIS law will be used .

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 590/851

2. Second possibility: the user defines the injection laws:

<b>INJECLAW</b> <b>LIQUID</b> <b>or STEAM</b> <b>or NONCOND1</b> <b>...</b> <b>or NONCOND4</b>	: keyword to indicate that an injection law is going to be defined. This law will replace the GSOUSER subroutine. If this keyword is used, it is followed by a keyword to indicate the type of injection: :LIQUID for a liquid source, STEAM for a steam source, : NONCOND1 for a 1 <sup>st</sup> noncondensable gas source etc ...
<b>lawj</b>	: law defining the evolution of the flow rate as a function of pressure when the <b>PRESSURE</b> keyword is used (law ‘PRESSURE’ – ‘FLOWRATE’), or defining the evolution in the flow rate as a function of time when the <b>ABSTIME</b> keyword is used (law ‘ABSTIME’ – ‘FLOWRATE’).
<b>VARI</b>	:Name of the variable  <u>for a liquid source :</u> <b>HL TL UNDERSAT</b> or <b>UNDERSPV</b> with : HL : liquid enthalpy (J/kg) TL : liquid temperature (°C) UNDERSAT : difference in liquid sub-saturation temperature in relation to P : $T_{sat}(P) - T_L$ , (°C) UNDERSPV : difference in liquid sub-saturation temperature in relation to PV : $T_{sat}(PV) - T_L$ , (°C)
<b>lawtja</b>	<u>for a steam (or NONCOND) source :</u> <b>HG TG OVERHEAT</b> or <b>OVERHEPV</b> with : HG : gas enthalpy (J/kg) TG : gas temperature (°C) OVERHEAT : difference in gas overheating temperature in relation to P : $T_G - T_{sat}(P)$ , (°C) OVERHEPV : difference in gas overheating temperature in relation to PV : $T_G - T_{sat}(PV)$ , (°C)
<b>COMPONENT name</b> <b>LIQPHASE lawl</b>	: OPTIONAL keyword to indicate that the source will also inject a radio-chemical component. The source must be of LIQUID or STEAM type. It is followed by the name of the radio-chemical component. In case of a LIQUID type of injection, it should be followed by: : law defining the evolution of the concentration in the liquid phase as a function of pressure when the <b>PRESSURE</b> keyword is used (law ‘PRESSURE’ – ‘CONCENL’), or defining the evolution of the concentration in liquid phase as a function of time when the <b>ABSTIME</b> keyword is used (law ‘ABSTIME’ – ‘CONCENL’). (CONCENL is given in GBq/kg or kg of chemical components / kg of liquid).
<b>or</b>	

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>GASPHASE lawg</b>	<b>Document technique DEN</b>	<a href="#">Page 591/851</a>

In case of a STEAM type of injection it should be followed by:

: law defining the evolution of the concentration in the gas phase as a function of pressure when the **PRESSURE** keyword is used (law ‘PRESSURE’ – ‘CONCENG’), or defining the evolution of the concentration in gas phase as a function of time when the **ABSTIME** keyword is used (law ‘ABSTIME’ – ‘CONCENG’). (CONCENG is given in GBq/kg or kg of chemical components / kg of gas).

3. Third possibility: the user defines the injection laws in the data deck and uses a special model at saturation conditions and with non condensable gas: this model is used for containment volume calculation

**SATURATE** : keyword to indicate that an injection with saturation conditions is going to be defined.

It is followed by a keyword to indicate the models of distribution of the fluid:

**VFM**: mixture before separation

**PFM**: separation before mixture

These models can be used if there are non condensable gases in the element.

**TOTFLOW** : keyword to indicate the total flowrate law.

**ENTHFLOW** : keyword to indicate the energy flowrate law.

**X1FLOW** : keyword to indicate the first non condensable gas flowrate law for **PFM** or **VFM** model.

The keyword must be **X2FLOW** if it is the 2<sup>nd</sup> non condensable gas, ... and so on.

**lawj** : law defining the evolution of the variable as a function of pressure when the **PRESSURE** keyword is used (law ‘PRESSURE’ – ‘FLOWRATE’), or defining the evolution of the variable as a function of time when the **ABSTIME** keyword is used (law ‘ABSTIME’ – ‘FLOWRATE’).

4. Fourth possibility: the user defines the two phases injection laws in the data deck :

**TWOPHASE** : keyword to indicate that the injection laws are going to be defined. This syntax will replace the GSOUSER subroutine. It is followed by a keyword to indicate the type of injection:

**LIQFLOW lawlf** and : to introduce liquid injection flowrate definition,

**GASFLOW lawgf** or : to introduce gas injection flowrate definition,

**TOTFLOW lawtf** : to introduce the total injection flowrate definition.

The laws (lawlf for the liquid, lawgf for the gas and lawtf for the fluid) define the evolution of the flow rate as a function of pressure when the **PRESSURE** keyword is used (law ‘PRESSURE’ – ‘FLOWRATE’), or define the evolution of the flow rate as a function of time when the **ABSTIME** keyword is used (law ‘ABSTIME’ – ‘FLOWRATE’).

**VARL listL<sup>1</sup>** **VARL**:Name of the variable for the liquid phase:  
**VARL** : **HL TL UNDERSAT OR UNDERSPV** with :  
**HL** : liquid enthalpy (J/kg)  
**TL** : liquid temperature (°C)  
**UNDERSAT** : difference in liquid sub-saturation temperature in relation to P :  
 $T_{sat}(P) - T_L$ , (°C)  
**UNDERSPV** : difference in liquid sub-saturation temperature in relation to PV :  
 $T_{sat}(PV) - T_L$ , (°C)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 592/851

**listL:** List of real numbers giving the evolution of VARL variable. It is associated with listt to define the VARL law as a function of time.

#### **VARG listG<sup>1</sup>**

**VARG:**Name of the variable for the gas phase.

**VARG : HG TG OVERHEAT OR OVERHEPV** with :

HG : gas enthalpy (J/kg)

TG : gas temperature (°C)

OVERHEAT : difference in gas overheating temperature in relation to P :  $T_G - T_{sat}(P)$ , (°C)

OVERHEPV : difference in gas overheating temperature in relation to PV :  $T_G - T_{sat}(P_V)$ , (°C)

**listG:** List of real numbers giving the evolution of VARG variable. It is associated with listt to define the VARG law as a function of time.

#### **ALFA listAL<sup>1</sup>**

**ALFA:** Void fraction of the source

**listAL:** List of real numbers giving the evolution of ALFA variable. It is associated with listt to define the ALFA law as a function of time..

#### **GAMMA listGA<sup>1</sup>**

**GAMMA:** slip ratio (Vg/Vl) of the source

This keyword has to be usedin the case of **TOTFLOW** source flow rate definition.

**listGA:** List of real numbers giving the values of GAMMA variable. Describing by the operator **REALLIST**, listGA associated with listt define the GAMMA source law as a function of time.

#### **Xi listXi<sup>1</sup>**

**Xi:** mass concentration of the noncondensible number “i” (i=1,4) (**optional**)

**listXi:** List of real numbers giving the evolution of Xi variable. It is associated with listt to define the Xi law as a function of time.

#### **LIQFRXi listRLi<sup>1</sup>**

**LIQFRXi:** concentration of the ratio-chemical element “i” (1 ≤ i ≤ 12) in the liquid phase (kg of chemical components / kg of liquid or GBq/kg) (**optional**)

**listRLi:** List of real numbers giving the evolution of LIQFRXi variable. It is associated with listt to define the LIQFRXi law as a function of time.

#### **GASFRXi listRGi<sup>1</sup>**

**GASFRXi:** concentration of the ratio-chemical element “i” (1 ≤ i ≤ 12) in the gas phase (kg of chemical components / kg of gas or GBq/kg) (**optional**)

**listRGi:** List of real numbers giving the evolution of GASFRXi variable. It is associated with listt to define the GASFRXi law as a function of time.

#### **ABSTIME listt<sup>1</sup>**

**ABSTIME:** Absolute time (s)

**listt:** List of real numbers giving the values of ABSTIME variable.

#### Example

#### **Sources on an axial element**

s1 =	SOURCE	AXIAL	icoldleg	EXTERNAL	p6
	ELEV	0.75	SECT	0.888	PERPENDI ;

<sup>1</sup>In these lists, the number of data values must be identical

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 593/851</a>

s2 =	SOURCE ELEV	AXIAL 0.50	icoldleg SECT	EXTERNAL 0.888	p6 ANGLE	1.3666 ;
s3 =	SOURCE ELEV ANGLE	AXIAL 0. 1.3666	icoldleg SECT CP1 ;	INTERNAL 0.888	p6	
s4 =	SOURCE ELEV ANGLE	AXIAL 0. 1.3666	icoldleg SECT	INTERNAL 0.888	p6	
with	INJECLAW law1 =	LIQUID LAW	law1	TL	law2 ;	
			'PRESSURE'	'FLOWRATE'		
	law2 =	LAW	80.d5	12.	90.d5	15. ;
			'ABSTIME'	'TL'	90.d0	320. ;
	0.d0		300.			
s5 =	SOURCE ELEV	AXIAL 0.0	icoldleg SECT	INTERNAL 0.888	p6 ANGLE	1.3666
with	INJECLAW law1 =	STEAM LAW	law1	OVERHEAT	law2 ;	
			'PRESSURE'	'FLOWRATE'		
	law2 =	LAW	80.d5	12.	90.d5	15. ;
			'PRESSURE'	'OVERHEPV'	90.d0	30. ;
	0.d0		5.			
s6 =	SOURCE ELEV	AXIAL 0.	icoldleg SECT	INTERNAL 0.888	p6 ANGLE	1.3666
with	INJECLAW law1 =	NONCOND1 LAW	law1	OVERHEPV	law2 ;	
			'PRESSURE'	'FLOWRATE'		
	law2 =	LAW	80.d5	12.	90.d5	15.;
			'PRESSURE'	'OVERHEPV'	90.d0	25. ,
	0.d0		5.			
s7 =	SOURCE ELEV	AXIAL 0.	icoldleg SECT	INTERNAL 0.888	p6 ANGLE	1.3666
with	INJECLAW law1 =	NONCOND4 LAW	law1	TG	law2 ;	
			'ABSTIME'	'FLOWRATE'		
	law2 =	LAW	0.	12.	100.	15. ;
			'PRESSURE'	'TG'	90.d5	320.;
	1.d5		300.			
s8 =	SOURCE ELEV	AXIAL 0.00	GENVAPI SECT	INTERNAL 1.000	PACCI PERPENDI	
	TWOPHASE	TOTFLOW TL	lawtf			
			REALIST	60.0D0	60.0D0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 594/851

with	lawtf =	LAW	TG	REALLIST	60.0D0	60.0D0
			ALFA	REALLIST	0.99D0	0.99D0
or	lawtf =	LAW	GAMMA	REALLIST	1.0D0	1.0D0
			ABSTIME	REALLIST	0.D0	1.D5 ;
with	lawlf =	LAW	'ABSTIME'	'FLOWRATE'		
			0.	12.	100.	15. ;
or	lawlf =	LAW	'PRESSURE'	'FLOWRATE'		
			1.D5	12.	50.D5	.15. ;
s9 =		SOURCE	AXIAL	GENVAPI	INTERNAL	PACCI
		ELEV	0.00	SECT	1.000	PERPENDI
			TWOPHASE	LIQFLOW	lawlf	GASFLOW
				TL	REALLIST	60.0D0
				TG	REALLIST	60.0D0
				ALFA	REALLIST	0.99D0
				ABSTIME	REALLIST	0.D0
				'ABSTIME'	'FLOWRATE'	1.D5 ;
				0.	12.	100.
with	lawlf =	LAW	'PRESSURE'	'FLOWRATE'		
			1.D5	12.	50.D5	.15. ;
or	lawgf =	LAW	'ABSTIME'	'FLOWRATE'		
and	lawgf =	LAW	0.	12.D-3	100.	15.D-3 ;
or	lawgf =	LAW	'PRESSURE'	'FLOWRATE'		
			1.D5	12.D-3	50.D5	.15.D-3 ;

#### Sources on an axial element with injection of incondensible gases and radio-chemical components

s1 =		SOURCE	AXIAL	froide	INTERNAL	p6
		ELEV	0.61	SECT	0.038	ANGLE
with	law1 =	LAW	INJECLAW	LIQUID	law1	TL
			COMPONENT	HPLUS	LIQPHASE	law3
with	law1 =	LAW	COMPONENT	BORON	LIQPHASE	law4 ;
			'PRESSURE'	'FLOWRATE'		
with	law2 =	LAW	1.d5	46.3	130.d5	6.9
			150.d5	0. ;		
with	law3 =	LAW	'PRESSURE'	'TL'		
			1.d5	20.	150.d5	20. ;
with	law4 =	LAW	'PRESSURE'	'CONCENL'		
			1.d5	5.d-4	150.d5	6.d-4 ;
s2 =		SOURCE	AXIAL	GENVAPI	INTERNAL	PACCI
		ELEV	0.00	SECT	1.000	PERPENDI
with	lawtf =	LAW	TWOPHASE	TOTFLOW	lawtf	
				TL	REALLIST	60.0D0
with	lawtf =	LAW		TG	REALLIST	60.0D0
				ALFA	REALLIST	0.01D0

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 595/851

			GAMMA	REALLIST	1.0D0	1.0D0	
			X1	REALLIST	1.D-5	1.D-5	
			X2	REALLIST	1.D-5	1.D-5	
			X3	REALLIST	1.D-5	1.D-5	
			LIQFRX1	REALLIST	1.D-7	1.D-7	
			LIQFRX2	REALLIST	1.D-7	1.D-7	
			GASFRX1	REALLIST	1.D-7	1.D-7	
			GASFRX2	REALLIST	1.D-7	1.D-7	
			ABSTIME	REALLIST	0.D0	1.D5 ;	
with	lawtf =	LAW	'ABSTIME'	'FLOWRATE'			
		0.	12.	100.	15. ;		
or	lawtf =	LAW	'PRESSURE'	'FLOWRATE'			
		1.D5	12.	50.D5.	15. ;		
 s3 =	 SOURCE	AXIAL	GENVAPI	INTERNAL	PACCI		
	ELEV	0.00	SECT	1.000	PERPENDI		
		TWOPHASE	LIQFLOW	lawlf	GASFLOW	lawgf	
			TL	REALLIST	60.0D0	60.0D0	
			TG	REALLIST	60.0D0	60.0D0	
			ALFA	REALLIST	0.01D0	0.01D0	
			X1	REALLIST	1.D-5	1.D-5	
			X2	REALLIST	1.D-5	1.D-5	
			X3	REALLIST	1.D-5	1.D-5	
			LIQFRX1	REALLIST	1.D-7	1.D-7	
			LIQFRX2	REALLIST	1.D-7	1.D-7	
			GASFRX1	REALLIST	1.D-7	1.D-7	
			GASFRX2	REALLIST	1.D-7	1.D-7	
			ABSTIME	REALLIST	0.D0	1.D5 ;	
with	lawlf =	LAW	'ABSTIME'	'FLOWRATE'			
		0.	12.	100.	15. ;		
or	lawlf =	LAW	'PRESSURE'	'FLOWRATE'			
		1.D5	12.	50.D5.	15. ;		
and	lawgf =	LAW	'ABSTIME'	'FLOWRATE'			
		0.	12.D-3	100.	15.D-3 ;		
or	lawgf =	LAW	'PRESSURE'	'FLOWRATE'			
		1.D5	12.D-3	50.D5.	15.D-3 ;		

### Sources on a volume element

		VOLUME	volinf	INTERNAL			
	SOURCE	0.2	SECT	0.888			
	ELEV	LENGTH	0.2	INJECLAW	LIQUID		
		law1	TL	law2 ;			
with	law1 =	LAW	'PRESSURE'	'FLOWRATE'			
			80.d5	12.	90.d5	15. ;	
	law2 =	LAW	'ABSTIME'	'TL'			
			0.d0	300.	90.d0	320. ;	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<b>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</b>
	<b>Document technique DEN</b>	Page 596/851

s2 =	SOURCE ELEV	VOLUME 0.2 LENGTH law1	volinf SECT 0.2 TL	INTERNAL 0.888 INJECLAW law2 ;	LIQUID	
with	law1 =	LAW	'PRESSURE' 80.d5	'FLOWRATE' 12.	90.d5	15. ;
	law2 =	LAW	'ABSTIME' 0.d0	'TL' 300.	100.d0	320. ;
s3 =	SOURCE ELEV	VOLUME 0.2 LENGTH law1	volinf SECT 0.2 OVERHEAT	INTERNAL 0.888 INJECLAW law2 ;	STEAM	
with	law1 =	LAW	'ABSTIME' 0.d0	'FLOWRATE' 1.	100.d0	15. ;
	law2 =	LAW	'ABSTIME' 0.d0	'OVERHEAT' 5.	90.d0	30. ;
s4 =	SOURCE ELEV	VOLUME 0.2 LENGTH NONCOND1	volinf SECT 0.2 law1	INTERNAL 0.888 INJECLAW OVERHEPV	law2 ;	
with	law1 =	LAW	'PRESSURE' 80.d5	'FLOWRATE' 12.	90.d5	15. ;
	law2 =	LAW	'PRESSURE' 1.d5	'OVERHEPV' 5.	100.d5	25. ;
s5 =	SOURCE ELEV	VOLUME 0.2 LENGTH NONCOND4	volinf SECT 0.2 law1	INTERNAL 0.888 INJECLAW TG	law2 ;	
with	law1 =	LAW	'ABSTIME' 0.d0	'FLOWRATE' 1.	100.d0	15. ;
	law2 =	LAW	'PRESSURE' 1.d5	'TG' 300.	90.d5	320. ;
s6 =	SOURCE	VOLUME ELEV TWOPHASE	VOLSUP 0.2 TOTFLOW 1	INTERNAL SECT 0.01 awft	LENGTH 0.0	
			TL	REALLIST	150.D0	150.D0
			TG	REALLIST	150.D0	150.D0
			ALFA	REALLIST	0.01D0	0.01D0
			GAMMA	REALLIST	1.0D0	1.0D0
			ABSTIME	REALLIST	0.D0	1.D5 ;
with	lawft =	LAW	'ABSTIME' 0.d0	'FLOWRATE' 1.	100.d0	1. ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 597/851</a>

s6 =            SOURCE       VOLUME       VOLSUP       INTERNAL  
                 ELEV            0.2           SECT            0.01           LENGTH        0.0  
                               TWOPHASE      LIQFLOW      lawfl            REALIST       150.D0        150.D0  
     TL                REALIST       150.D0        150.D0  
     TG                REALIST       0.01D0       0.01D0  
     ALFA            REALIST       1.0D0        1.0D0  
     GAMMA           REALIST       0.D0         1.D5 ;  
 with            lawfl =        LAW           'ABSTIME'      'FLOWRATE'  
     0.d0            1.            100.d0        1. ;  
                   lawfg =        LAW           'ABSTIME'      'FLOWRATE'  
     0.d0            1.d-3        100.d0        1.d-3 ;

#### Sources using PFM or VFM option

BRECHV1=	SOURCE ELEV SATURATE TOTFLOW ENTHFLOW X1FLOW X2FLOW	VOLUME 40. PFM LAW21 LAW22 LAW23 LAW24	CONTAIN SECT	INTERNAL 1.D3	LENGTH	0.0
BRECHV2=	SOURCE ELEV VFM ;	VOLUME 40	CONTAIN SECT	EXTERNAL 1.D3	LENGTH	0.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 598/851

198

## SOURIS OPERATOR

The **SOURIS** operator is used to describe a source in a volume with a [SIS \(RIS\)](#) overflowing model. The SOURIS source is used to represent the flow through the break into the containment, in situations when the safety injection flowrate is entirely released at the break (typically long term stage of a [LOCA](#)). The safety injection may be in the cold loop and/or in the hot loop. The break may be located in the cold loop or in the hot loop. The phases composition is not specified, but it is evaluated by the code.

The **SOURIS** operator creates, in *data block*, a SOURIS by defining its characteristics. A SOURIS can be defined only on a VOLUME element. The SOURIS operator only defines and locates a source but does not open it (see [OPEN, CLOSE](#)).

1. **INTERNAL SOURCE** ; The injection is automatically controlled within the computation. Control is made by giving evolution laws when the source is defined, covering the change in the different variables of the injection.
2. **EXTERNAL SOURCE** : The injection is controlled by the user in the *command block* of the data set, using **CATHARE** Computation Variables ([CCV](#)).

All the variables are defined in the block data in the definition of the operator. Only the variables which are defined by a law in an internal SOURIS can be modified by CCV in an external SOURIS.

**Geometry and location of the source :** The geometry and the location of a SOURIS are identical to those of a classical source in a volume.

### Associated Keywords

[OPEN, CLOSE](#)

### Syntax

#### for an internal SOURIS

S1 =	<b>SOURIS</b>	<b>VOLUME</b>	<b>elem</b>	<b>INTERNAL</b>	
		<b>ELEV</b>	elevi	<b>SECT</b>	seci
		<b>LENGTH</b>	longi		
	<b>(VFM</b>	or	<b>PFM )</b>	<b>TRISON</b>	topen
				<b>TOTFLOW</b>	lawqtot
				<b>ENTHFLOW</b>	lawhtot
				<b>(X1FLOW</b>	lawqx1
				<b>X4FLOW</b>	... lawqx4 )

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 599/851

<b>COLDFLOW</b>	lawqcold
<b>TLRIS</b>	tl
<b>POSIRIS</b>	ip
<b>(HOTFLOW</b>	lawqhot )
<b>RESPOWER</b>	lawpres
<b>(CONDRATE</b>	zcd ) ;

**for an external SOURIS :**

<b>S1 =</b>	<b>SOURIS</b>	<b>VOLUME</b> <b>ELEV</b> <b>LENGTH</b>	<b>elem</b> <b>elevi</b> <b>longi</b>	<b>EXTERNAL</b> <b>SECT</b>	<b>seci</b>
				<b>TRISON</b>	topen
				<b>COLDFLOW</b>	zqcold
				<b>TLRIS</b>	tl
				<b>POSIRIS</b>	ip
				<b>(HOTFLOW</b>	zqhot )
				<b>RESPOWER</b>	zpres
				<b>(CONDRATE</b>	zcd ) ;

**elem** : VOLUME type element  
**INTERNAL** : keyword to indicate that the source is an internal source. For an external source, the keyword **INTERNAL** will be replaced by the keyword **EXTERNAL**.

**ELEV elevi** : keyword followed by a real number defining the elevation of the source with respect to the bottom of the volume. It must be  $\geq 0$ . and  $\leq \text{£}$  (height of the volume).

**SECT seci** : keyword followed by a real number  $> 0$ . defining the cross-section of the injection opening ( $\text{m}^2$ ). This is followed by :

**LENGTH longi** : keyword followed by a real number  $\geq 0$ . defining the source penetration length in the volume.

**VFM or PFM** : OPTIONAL keyword to indicate the models of distribution of the fluid at the break :  
**VFM**: mixture before separation  
**PFM**: separation before mixture  
 These models can be used if there are non condensable gas in the volume.

**TRISON topen** : keyword followed by a real number  $\geq 0$ . defining the time when the RIS model will be activated.

**TOTFLOW lawqtot** : (case of internal SOURIS) keyword defining the total flowrate of the injection . It is followed by the name of the law giving the FLOWRATE VARIATIONS function of time.

**ENTHFLOW lawhtot** : (case of internal SOURIS) keyword defining the total power of the injection . It is followed by the name of the law giving the POWER VARIATIONS function of time

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 600/851</a>

<b>X1FLOW</b> <b>lawqx1</b>	: (case of internal SOURIS) keyword defining the flowrate of the first non-condensable gas in the injection. It is followed by the name of the law giving the FLOWRATE VARIATIONS function of time. By default, the flowrate is set to 0.d0. The keyword must be <b>X2FLOW</b> if it is the 2 <sup>nd</sup> non condensable gas, ... and so on.
	<p><b>Remark :</b> In case of an <b>EXTERNAL SOURIS</b>, TOTFLOW, ENTHFLOW and optionaly XiFLOW <u>values have to be given before opening the gadget</u>. If not, calculation will either stop or give an irrealist result.</p>
<b>COLDFLOW</b> <b>lawqcold</b>	: keyword defining the flowrate of the injection in the cold loop. It is followed by : : the name of the law giving the FLOWRATE VARIATIONS function of time if the SOURIS is internal,
or <b>zqcold</b>	: a real number $\geq 0$ . defining the flowrate if the SOURIS is external.
<b>TLRIS tl</b> <b>POSIRIS ip</b>	: keyword followed by a real number defining the temperature of the injection flow. : keyword followed by a integer defining the position of the break: Posiris = 1 for the break in hot loop and the injection in cold loop, Posiris = 2 for the break in cold loop and the injection in cold loop, Posiris = 3 for the break in hot loop and the injection in both hot and cold loop simultaneously, Posiris = 4 for the break in cold loop and the injection in both hot and cold loop simultaneously.
<b>HOTFLOW</b> <b>lawqhot</b>	: OPTIONAL keyword defining the flowrate of the injection in the hot loop. It is followed by : : the name of the law giving the FLOWRATE VARIATIONS function of time if the SOURIS is internal,
or <b>zqhot</b>	: a real number $\geq 0$ . defining the flowrate if the SOURIS is external.
<b>RESPOWER</b> <b>lawpres</b>	: keyword defining the residual power of the core . It is followed by : : the name of the law giving the RESIDUAL POWER VARIATIONS function of time if the SOURIS is internal,
or <b>zpres</b>	: a real number $\geq 0$ . defining the residual power if the SOURIS is external.
<b>CONDRATE zcd</b>	: OPTIONAL keyword followed by a real number $\geq 0$ . and $\leq 1$ . defining the condensation rate, at the injection.

### Example

<b>s1 =</b>	<b>SOURIS</b>	<b>VOLUME</b>	<b>volinf</b>	<b>EXTERNAL</b>	
		ELEV	0.2	SECT	0.888
		LENGTH	0.2		
	<b>VFM</b>	TRISON	10.D0		
		COLDFLOW	0.6d0	TLRIS	27

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 601/851

		POSIRIS	2		
		RESPOWER	5.D0	CONDRATE	0.25d0;
s2 =	SOURIS	VOLUME	volinf	INTERNAL	
		ELEV	0.2	SECT	0.888
		LENGTH	0.2		
	PFM	TRISON	10.D0		
		TOTFLOW	law1	ENTHTOT	law2
		X1FLOW	law3		
		COLDFLOW	law4	TLRIS	27
		POSIRIS	2		
		HOTFLOW	law5	RESPOWER	law6
		CONDRATE	0.25d0 ;		
with	Law1 =	LAW	‘ABSTIME’	‘FLOWRATE’	
		0.d0	300.	90.d0	320. ;
	Law2 =	LAW	‘ABSTIME’	‘ENTHTOT’	
		0.d0	300.	90.d0	320. ;
	Law3 =	LAW	‘ABSTIME’	‘FLOWRATE’	
		0.d0	300.	90.d0	320. ;
	Law4 =	LAW	‘ABSTIME’	‘COLDFLOW’	
		0.d0	300.	90.d0	320. ;
	Law5 =	LAW	‘ABSTIME’	‘HOTFLOW’	
		0.d0	300.	90.d0	320. ;
	Law6 =	LAW	‘ABSTIME’	‘RESPOWER’	
		0.d0	300.	90.d0	320. ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 602/851

199

## SPALL DIRECTIVE

The **SPALL** directive, in *command block*, enables the user to eliminate the external oxide layer around the cladding for a specified fuelchar.  
It becomes effective when called. It must be used at t=0.

### Associated Keywords

FUELCHAR, OXRATE, SPALLECR, SPALLOX

### Syntax

**SPALL**      fuelchar1      ;

**fuelchar1**      : name of the fuelchar element for which the external oxide layer is to be eliminated.

**NB1** : This directive impacts directly the **CATHARE** calculation.

### Example

SPALL      CARCHO      ;

**NB2** : the FORTRAN subroutine called in PILOT is SPALL: CALL SPALL ( OBJNAM, \*9999)

OBJNAM      CHARACTER\*8 name of the fuelchar for which the external oxide layer is eliminated

 <b>ce</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 603/851

200

## SPALLECR DIRECTIVE

The **SPALLECR** directive, in command block, enables the user to eliminate the initial external oxide layer around the cladding in the kinetic oxidation law for a specified fuelchar. For numerical reasons, in the calculation, the initial external oxide layer thickness is set to  $0.1\mu m$ .

It becomes effective when called. It must be used at t=0.

### Associated Keywords

FUELCHAR, SPALL, OXRATE, SPALLOX

### Syntax

**SPALLECR**    fuelchar1        ;

**fuelchar1**        : name of the fuelchar element for which the external oxide layer is to be eliminated.

**NB1** : This directive impacts directly the **CATHARE** calculation.

### Example

SPALLECR    CARCHO        ;

**NB2** : the FORTRAN subroutine called in PILOT is SPALLECR: CALL SPALLECR ( OBJNAM, \*9999)

OBJNAM        CHARACTER\*8 name of the fuelchar for which the external oxide layer is eliminated

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 604/851

# 201

## SPALLOX DIRECTIVE

The **SPALLOX** directive, in *command block*, enables the user to eliminate the external oxide layer around the cladding for a specified fuelchar for the parallel calculation of oxidation rate (calculated by the **OXRATE** directive). The **SPALLOX** directive is similar to the **SPALL** directive, but is used only in the parallel calculation of the oxidation rate. For this reason, it does not impact the **CATHARE** calculation, and must be used after a call to the **OXRATE** directive. It becomes effective when called. It must be used at t=0.

### Associated Keywords

**FUELCHAR, SPALL, OXRATE, SPALLECR**

### Syntax

**SPALLOX**      fuelchar1      ;

**fuelchar1**      : name of the fuelchar element for which the external oxide layer is to be eliminated for the oxidation rate calculation.

**NB :**

1. This directive doesn't impact directly the **CATHARE** calculation.
2. This directive must be called after **OXRATE**, for a specific fuel object.

### Example

```
OXRATE      CARCHO      BAKERJUS1    ;
...
SPALLOX     CARCHO ;
```

**NB :** the FORTRAN subroutine called in PILOT is SPALLOX: CALL SPALLOX ( OBJNAM, \*9999)

<b>OBJNAM</b>	CHARACTER*8 name of the fuelchar for which the external oxide layer is eliminated for the oxidation rate calculation
---------------	--

<sup>1</sup>Example of a specific oxidation law available

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 605/851

# 202

## STARALTR DIRECTIVE

The **STARALTR** directive is used in the *command block* to restart the coupling mode between the alternator of the SHAFT and the other elements of the SHAFT. The directive STARALTR can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

SHAFT, STARALTR, STARSHAF, STOPALTR, STOPSHAF

### Syntax

**STARALTR** shaftname ;

**shaftname** : name of the SHAFT (turbomachine object)

### Example

STARALTR arbre1 ;

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following: CALL STARALTR ( OBJDIR, 0, 0, 0, CVAL , IVAL , RVAL, \*9999)

OBJDIR	: array of character*8 words. It contains the name of the pumpchar
CVAL	: array of character*8 words. Not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 606/851

# 203

## STAROVRF DIRECTIVE

The **STAROVRF** directive is used in the *command block* to restart the overflowing model used with **PIQARE** operator and stopped with directive **STOPOVRF**. The directive **STAROVRF** can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**PIQARE, STOPOVRF**

### Syntax

**STAROVRF**    arenam              ;

**arenam**                          : PIQARE name

### Example

```
STOPOVRF    Are1 ;
GOPERM ;
```

```
STAROVRF    Are1 ;
```

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is ARESTATE. Arguments are the following: CALL ARESTATE ( CVAL, NVAL, \*9999)

CVAL	: array of character*8 words. It contains the name of the piqare.
NVAL	: Integer. Overflowing model state (here 1 to activate).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 607/851

204

## STARPUCK DIRECTIVE

The **STARPUCK** directive is used in the *command block* to restart a pump stopped with directive **STOPPUMP**. Such a restart is possible if the keyword **BLOCKED** has been specified in directive **STOPPUMP**. The directive **STARPUCK** can be applied on any kind of pumps (asynchronous or not) just before the steady state calculation or at any time of the transient calculation.

**NB:** Pump speed should be defined using **PUMPMOD** directive before restart. Moreover, for an electrical pump, nominal supply voltage and nominal supply frequency should be also given using **WRITE** directive before restart. These values are normalized according to the **TENSION** and **FREQUEN** defined in the **PUMPCHAR** operator.

### Associated Keywords

**PUMPCHAR, STOPPUMP**

### Syntax

**STARPUCK**    **pumpcj**                ;

**pumpcj**                : name of the PUMPCHAR object (0D pump).

### Example

```
STOPPUMP    pumpc1      BLOCKED ;
GOPERM      ;
```

\*\*\*\*\* Necessary for electrical 0D-pump only \*\*\*\*\*

```
WRITE        1.0          VNOMIN      pumpc1 ;
WRITE        1.0          FREQALIM   pumpc1 ;
```

\*\*\*\*\* Necessary for all kind of pumps \*\*\*\*\*

```
STARPUCK    pumpc1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 608/851

PUMPMOD	pumpc1	ROTATION	RADSEC
RELATIVE		REALLIST	0.0D0            10.D0
ROTV		REALLIST	1.0D0            2.0D0 ;

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following: CALL OUVRIR ( OBJDIR, CTYPE, 0, 0, 0, CVAL , IVAL , RVAL, \*9999)

OBJDIR	: array of character*8 words. It contains the name of the pumpchar.
CTYPE, CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 609/851</a>

205

## STARSHAF DIRECTIVE

The **STARSHAF** directive is used in the *command block* to activate the coupling mode between the elements of the SHAFT. The STARSHAF directive imposes the master rotating speed to the SLAVE elements. The directive STARSHAF can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**SHAFT, STARALTR, STARSHAF, STOPALTR, STOPSHAF, SHAFTMOD**

### Syntax

**STARSHAF shaftname ;**

**shaftname** : name of the SHAFT object (turbomachine object).

### Example

**STARSHAF arbre1 ;**

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following: CALL STARSHAF ( OBJDIR, 0, 0, 0, CVAL , IVAL , RVAL, \*9999)

<b>OBJDIR</b>	: array of character*8 words. It contains the name of the pumpchar
<b>CVAL</b>	: array of character*8 words not used in calculation.
<b>IVAL</b>	: integer not used in calculation.
<b>RVAL</b>	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 610/851

# 206

## STARSLURG DIRECTIVE

The **STARSLURG** directive is used in the *command block* to activate MAPSURGE model for a compressor (**TCOMCHAR** operator). The directive **STARSLURG** can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**TCOMCHAR, STARSLURG, STOPSLURG**

### Syntax

**STARSLURG compname ;**

**compname** : name of the compressor object (TCOMCHAR operator)

### Example

**STARSLURG Compre1 ;**

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following ones: CALL STARSLURG ( OBJDIR, CTYPE, 0, 0, 0, CVAL , IVAL , RVAL, \*9999)

OBJDIR	: array of character*8 words. It contains the name of the pumpchar.
CTYPE,	: array of character*8 words. It contains the word 'TCOMCHAR'.
CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 611/851

# 207

## STARTMIX DIRECTIVE

The **STARTMIX** directive is used in the *command block* to enable a flomixer. The directives **STARTMIX** and **STOPMIX** can be applied one or several times in a calculation.

### Associated Keywords

**STOPMIX, FLOMIXER, VOLUME**

### Syntax

**STARTMIX mixname ;**

**mixname** : FLOMIXER name

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following: CALL OUVRIR ( OBJDIR, CTYPE, 0, 0, 1, CVAL , IVAL , RVAL, \*9999)

OBJDIR	: array of character*8 words containing the name of the flomixer name
CTYPE, CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real containing the value of dtmix

### Example

#### In data block

MELANGE=	FLOMIXER	2	FROM	VOLDOWN	DOWNROMP	DOWNINT
	TO	PLENSUP	SUPROMPU	SUPINTAC		
	USER	0.7D0	0.30D0			
	AGMAX	1.D-1	DQMAX	1.D0;		

#### In command block

**STARTMIX MELANGE ;**

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 612/851

# 208

## STARTVC DIRECTIVE

In the *command block* only and for volume element only.

The **STARTVC** directive activates the use of specific correlations for heat transfer from walls to fluid in case of film condensation during containment calculations. The choice of the correlation is made earlier through the **VFILM** operator in the *data block*.

**Remark:** The **VFILM** operator is not available with option **GRIDS 5**.

### Associated Keywords

**VFILM, STOPVC, VOLUME**

### Syntax

**STARTVC** elem ;

**elem** : name of the volume element.

### Example

```
STARTVC    CONT01 ;
```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 613/851

209

## STDYFUEL DIRECTIVE

The **STDYFUEL** directive is used in command block to trigger steady state computation of a **CATAFUEL** element. The imposed hydraulic conditions must have been initialized, before the directive STDYFUEL, by a first reading of the hydraulic file (see **READHCAT** and **READHEXT**).

**N.B.** The results of the **CATAFUEL** steady state computation will be printed systematically by the code.

### Associated Keywords

**CATAFUEL**

### Syntax

**STDYFUEL**    cata                ;

**cata**                              : name of the catafuel element (define by operator **CATAFUEL**) for which the steady state has to be calculated.

**NB** : The corresponding FORTRAN subroutine called in PILOT is STDYFUEL: CALL STDYFUEL (CVAL, \*9999).

**CVAL**                              : array of character\*8 words. It contains the name of the catafuel element.

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<p>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
	<p><b>Document technique DEN</b></p>	<p>Page 614/851</p>

# 210

## STOPACON DIRECTIVE

The **STOPACON** directive, in command block, enables the user to stop the Aconda law for convective vapor heat transfer enhancement in case of cladding rupture, for a specified fuelchar. It stops the model activated by the directive HTCBA-CON.

It becomes effective when called.

### Associated Keywords

FUELCHAR, HTCBA CON

### Syntax

**STOPACON**    fuelchar1        ;

**fuelchar1**                    : name of the fuelchar element for which the model is going to be stopped.

**NB1** : This directive impacts directly the Cathare calculation.

### Example

STOPACON    CARCHO        ;

**NB** : the FORTRAN subroutine called in PILOT is STOPACON: CALL STOPACON ( OBJNAM, \*9999).

**OBJNAM**                    CHARACTER\*8 name of the fuelchar element for which the model is going to be stopped.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 615/851

# 211

## STOPALTR DIRECTIVE

The **STOPALTR** directive is used in the *command block* to stop the coupling mode between the alternator of the **SHAFT** and the other elements of the **SHAFT**. The directive STOPALTR can be applied just before the steady state calculation or at any time of the transient calculation.

**NB :** the coupling mode between the **MASTER** and the **SLAVE** elements of the **SHAFT** is still activated (use **STOPSHAF** to deactivate it).

### Associated Keywords

**SHAFT, STARALTR, STARSHAF, STOPALTR, STOPSHAF, SHAFTMOD**

### Syntax

**STOPALTR**    shaftname        ;

**shaftname**            : name of the turmomachine object (**SHAFT**).

### Example

**STOPALTR**    arbre1 ;

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following: CALL STOPALTR ( OBJDIR, 0, 0, 0, CVAL , IVAL , RVAL, \*9999).

<b>OBJDIR</b>	: array of character*8 words. It contains the name of the pumpchar.
<b>CVAL</b>	: array of character*8 words not used in calculation.
<b>IVAL</b>	: integer not used in calculation.
<b>RVAL</b>	: real not used in calculation.



# **STOPFUEL DIRECTIVE**

The **STOPFUEL** directive, in *command block*, enables the user to deactivate the adjustment model launched by the **RSETFUEL** directive. The **STOPFUEL** directive can only be used after the **RSETFUEL** directive. It becomes effective when called and may be used several times during calculation.

### **Associated Keywords**

## FUELCHAR, RSETFUEL

## Syntax

**STOPFUEL** fuelchar1 ;

**fuelchar1** : name of the fuelchar element for which the RSETFUEL model must be deactivated.

## Example

STOPFUEL carmoy ;

**N.B :** the FORTRAN subroutine called in PILOT is STOPFUEL; CALL STOPFUEL ( OBJNAM, \*9999).

**OBJNAM**            CHARACTER\*8 name of the fuelchar for which the RSETFUEL model must be deactivated

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 617/851

213

## STOPMIX DIRECTIVE

The **STOPMIX** directive is used in the *command block* to disable a flomixer. The directives **STARTMIX** and **STOPMIX** can be applied one or several times in a calculation.

### Associated Keywords

**STARTMIX, FLOMIXER, VOLUME**

### Syntax

**STOPMIX mixname ;**

**mixname** : FLOMIXER name.

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is FERMER. Arguments are the following: CALL FERMER ( OBJDIR, CTYPE, 0, 0, 0, CVAL , IVAL , RVAL, \*9999).

OBJDIR	: array of character*8 words. It contains the name of the flomixer.
CTYPE, CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

### Example

*In data block*

```
MELANGE= FLOMIXER    2
          FROM      VOLDOWN   DOWNROMP  DOWNINT
          TO        PLENSUP   SUPROMPU SUPINTAC
          USER      0.7D0    0.30D0
          AGMAX    1.D-1    DQMAX     1.D0;
```

*In command block*

**STOPMIX MELANGE ;**

 <b>ceasaclay</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 618/851

# 214

## STOPNEUT DIRECTIVE

The **STOPNEUT** directive, placed in the *command block*, enables to stop the point kinetics model for an element **FUELPLAQ**.

The kinetic calculation is continued using the “power versus relative time” user’s laws input in the POWRESI and POWNEUT options of the FUELPLAQ directive. These laws and POWRESI / POWNEUT values must be defined in the data bloc and used in the FUELPLAQ element (see example).

### Associated Keywords

**FUELPLAQ, GONEUT, CORE**

### Syntax

**STOPNEUT core1 ;**

**core1** : core name.

### Example

**Data block:**

```

BEGIN      DATA;
...
LOINEUT= LAW      'TIME'      'POWER'
                0.D0        1.0D0
                100.D0     1.0D0 ;
LOIRESI=  LAW      'TIMEP'     'POWER'
                0.D0        1.0D0
                100.D0     1.0D0 ;
...

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 619/851

```

PLAQUE= FUELPLAQ GRAPPE INTERNAL
          PLANE
      POWNEUT 61772.75
      POWRESI 6517.25
      LAWNEUT LOINEUT    LAWRESI    LOIRESI
...
END      DATA;

```

**Command block:**

```

GONEUT CORE1 ;
...
...
STOPNEUT CORE1;
...
END      EXEC      ;

```

**NB:** The corresponding FORTRAN subroutine called in PILOT is STOPNEUT.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 620/851

215

## STOPOVRF DIRECTIVE

The **STOPOVRF** directive is used in the *command block* to stop the overflowing model used with **PIQARE** operator. The directive STOPOVRF can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**PIQARE, STAROVRF**

### Syntax

**STOPOVRF**    arename                ;

rename                                    : PIQARE name

### Example

STOPOVRF    Are1 ;  
GOPERM ;

STAROVRF    Are1 ;

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is ARESTATE. Arguments are the following: CALL ARESTATE ( CVAL, NVAL, \*9999).

CVAL                                    : Name of the piqare.  
NVAL                                    : Overflowing model state (here 0 to deactivate).

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 621/851

# 216

## STOPPUMP DIRECTIVE

The **STOPPUMP** directive is used in the *command block* to turn off the electrical power supply of the 0D-pump.

### Associated Keywords

PUMPCHAR, STARPUmp

### Syntax

**STOPPUMP**    pumpcj                (**BLOCKED**);

<b>pumpcj</b>	: name of the PUMPCHAR object (0D-pump)
<b>BLOCKED</b>	: OPTIONAL keyword that indicates the pump is not stopped but only blocked and can be restarted later by directive STARPUmp. It forces the latch arm fall down and sets the rotation speed to zero. For an asynchronous motor model the supply voltage and the supply frequency are also set to zero.

### Example

```
STOPPUMP  pumpc1 ;
STOPPUMP  pumpc2      BLOCKED ;
```

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is FERMER. Arguments are the following : CALL FERMER ( OBJDIR, CTYPE, NCVAL, 0, 0, CVAL , IVAL , RVAL, \*9999).

<b>OBJDIR</b>	: array of character*8 words. It contains the name of the pump.
<b>CTYPE,</b>	: array of character*8 words not used in calculation.
<b>NCVAL</b>	: integer value, if keyword BLOCKED is used =1, else 0.
<b>CVAL</b>	: array of character*8 words. It contains the keyword BLOCKED if it was used (any word in other case).
<b>IVAL</b>	: integer not used in calculation.
<b>RVAL</b>	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 622/851

217

## STOPSHAF DIRECTIVE

The **STOPSHAF** directive is used in the *command block* to stop the coupling mode between the elements of the **SHAFT**. The directive STOPSHAF can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**SHAFT, STARALTR, STARSHAF, STOPALTR, STOPSHAF, SHAFTMOD**

### Syntax

**STOPSHAF** shaftname ;

**shaftname** : name of the SHAFT object (turbomachine)

### Example

STOPSHAF arbre1 ;

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following : CALL STOPSHAF ( OBJDIR, 0, 0, 0, CVAL , IVAL , RVAL, \*9999)

OBJDIR	: array of character*8 words. It contains the name of the pumpchar
CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 623/851

# 218

## STOPSURG DIRECTIVE

The **STOPSURG** directive is used in the *command block* to deactivate MAPSURGE model for a compressor (**TCOMCHAR** operator). The directive STOPSURG can be applied just before the steady state calculation or at any time of the transient calculation.

### Associated Keywords

**TCOMCHAR, STARSURG**

### Syntax

**STOPSURG compname ;**

**compname** : name of the compressor object (TCOMCHAR operator).

### Example

**STOPSURG Compre1 ;**

**N.B. :** The corresponding FORTRAN subroutine called in PILOT is OUVRIR. Arguments are the following : CALL STOPSURG ( OBJDIR, CTYPE, 0, 0, 0, CVAL , IVAL , RVAL, \*9999).

OBJDIR	: array of character*8 words. It contains the name of the pumpchar.
CTYPE,	: array of character*8 words. It contains the word 'TCOMCHAR'.
CVAL	: array of character*8 words not used in calculation.
IVAL	: integer not used in calculation.
RVAL	: real not used in calculation.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 624/851

# 219

## STOPVC DIRECTIVE

The **STOPVC** directive deactivates the use of specific correlations for heat transfer from walls to fluid in case of film condensation during containment calculations.

**Remark:** The **VFILM** operator is not available with option **GRIDS 5**.

### Associated Keywords

**VFILM, STARTVC, VOLUME**

### Syntax

**STOPVC** elem ;

**elem** : name of the volume element

### Example

**STOPVC** CONT01 ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 625/851</a>

220

## STOPYHL DIRECTIVE

The **STOPYHL** directive, in *command block*, enables the user to stop the Yao-Hochreiter-Leech (YHL) law for convective vapor heat transfer enhancement in case of cladding rupture, for a specified fuelchar. It stops the model activated by the directive **HTCBYHL**.

It becomes effective when called.

### Associated Keywords

**FUELCHAR**, **HTCBYHL**

### Syntax

**STOPYHL**      fuelchar1      ;

**fuelchar1**      : name of the fuelchar element for which the model is going to be stopped.

**NB1** : This directive impacts directly the **CATHARE** calculation.

### Example

**STOPYHL**      CARCHO      ;

**NB2** : the FORTRAN subroutine called in PILOT is STOPYHL : CALL STOPYHL ( OBJNAM, \*9999).

<b>OBJNAM</b>	CHARACTER*8 name of the fuelchar element for which the model is going to be stopped.
---------------	--

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 626/851

221

## STOREHYD DIRECTIVE

The **STOREHYD** directive is used in *data block* to specify and save the hydraulic variables necessary for future standalone fuel calculations (see **CATAFUEL** operator, option 2).

The format of the file where results are stored is BINARY or FORMAT and can be defined by the **OPTION** directive. The default format is BINARY.

**NB :** RESHCAT directive can be used to modify the default storage frequency.

### Associated Keywords

RESHCAT, HYDCHAN, CATAFUEL

### Syntax

```
STOREHYD (n)
    axial1      ...      axialn
    (NEUTRO   core_name) ;
    or          3dnam       hydnam1      hydnamn
    (NEUTRO   core_name) ;
```

**n** : not used. Default is 62 if BINARY or 63 if FORMATTED (use OPTION SAVE FORMAT for the FORT63 file).

**axial1 ... axialn** : list of axial elements for which the hydraulic state variables have to be stored.

**3dnam** : name of the threed element.

**hydnam1...hydnamn** : 1D hydraulic channels list previously defined by **HYDCHAN** operator for which the hydraulic state variables have to be stored.

**NEUTRO**  
**core\_name** : obsolescent OPTIONAL keyword followed by the name of the core. The residual and non residual powers are always stored in the hydraulic file. Used only if there is a core defined.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 627/851

<b>Example</b>
----------------

1. 1D example

COEURMOY= AXIAL ... ;

COEURCHO= AXIAL ... ;

**STOREHYD** COEURMOY COEURCHO  
;

2. 3D example

CUVE = THREED ... ;  
 CORE1 = CORE ... ;  
 HYDCHAN1= HYDCHAN ... ;  
 HYDCHAN2= HYDCHAN ... ;  
 HYDCHAN3= HYDCHAN ... ;  
**STOREHYD** CUVE  
HYDCHAN1 HYDCHAN2 HYDCHAN3  
**NEUTRO** CORE1 ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 628/851

222

## SWITCH DIRECTIVE

The **SWITCH** directive must be used to activate or deactivate the transmission of information between two objects linked by an **EXHYLINK** (Hydraulic coupling) or an **EXWALINK** (Thermal coupling). By default there is no communication between these objects.

### EXHYLINK objects case

If the first object is a gadget (sink,source,...), it must be open when switching on (or off) the link.

If the second object is a gadget (sink, source,...), it must be closed before switching on the link. Then the SWITCH ON directive automatically opens the gadget which must remain open while the link is activated. Then the SWITCH OFF directive deactivates the link and closes the second gadget.

**N.B.** When the link is not activated, the second gadget can be used as an usual external gadget. But before reactivating the link, the second gadget must be closed properly.

### EXWALINK objects case

To indicate to the system that a thermal coupling has to be activated or deactivated the keyword WALL is necessary. The thermal coupling can be only enabled after the steady state.

### Associated Keywords

**EXHYLINK, EXWALINK**

## 222.1 Activation

### Syntax

```
SWITCH      (WALL)
          Lihy1        (or        Lith1)        ON ;
```

Lihy1	: exhylink name
Lith1	: exwalink name. In this case, keyword WALL is mandatory.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 629/851

<b>Example</b>
----------------

**Case of a Hydraulic coupling**

SWITCH        Solink1        ON ;

**Case of a Thermal coupling**

SWITCH        WALL        wall1        ON ;

## 222.2 Deactivation

<b>Syntax</b>
---------------

**SWITCH**        **(WALL)**  
Lihy1              (or              Lith1)        **OFF;**

Lihy1              : exhylink name  
Lith1              : exwalink name. In this case, keyword WALL is mandatory.

<b>Example</b>
----------------

**Case of a Hydraulic coupling**

SWITCH        Solink1        OFF ;

**Case of a Thermal coupling**

SWITCH        WALL        wall1        OFF ;

**Global Examples**

**Example 1**

SRRI1 =        SINKRRI        VOLUME        ...        EXTERNAL        ...

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 630/851

EAS ...  
 ISBP ...  
 ...;

SREG1 = SOURCE VOLUME EXTERNAL  
 ...;

SOLINK1 = EXHYLINK SRRI1 SREG1 EAS ;  
 SOLINK2 = EXHYLINK SRRI1 SREG2 ISBP ;  
 OPEN SRRI1 ;  
 SWITCH SOLINK1 ON ;  
 ...  
 SWITCH SOLINK2 ON ;  
 ...  
 SWITCH SOLINK1 OFF ;  
 ...  
 SWITCH SOLINK2 OFF ;  
 ...  
 CLOSE SRRI1 ;

#### Example 2

SRRI2 = SINKRRI VOLUME INTERNAL ...  
 ...  
 EAS...  
 ... ;  
 SREG3 = SOURCE VOLUME EXTERNAL ... ;  
 SOLINK3 = EXHYLINK SRRI2 SREG3 EAS ;  
 OPEN SRRI2 ;  
 SWITCH SOLINK3 ON ;  
 ...  
 SWITCH SOLINK3 OFF ;  
 CLOSE SRRI2 ;

#### Example 3

RUPTU = RG ... ;  
 BRECHE = SOURCE VOLUME  
 ENCEINTE EXTERNAL ... ;  
 ASSIGN RG EXTERNAL ... ;  
 SOLINK EXHYLINK RUPTU BRECHE ;  
 ...  
 SWITCH SOLINK ON ;

#### Example 4

WPIPE1 = WALL PIPE1 ...;  
 WPIPE2 = WALL PIPE2 ...;  
 PAROI1 = EXWALINK WPIPE1 WPIPE2 IMPLICIT;  
 SWITCH PAROI1 ON ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 631/851

223

## TABLE DIRECTIVE

The **TABLE** directive is an obsolescent directive in the present version. The restore of all the *command block* variables is automatically done when using the **RESTORE** directive.

### Associated Keywords

INTEGER, DOUBLE, SAVE, REACTOR

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 632/851

# 224

## TCOMCHAR OPERATOR

The **TCOMCHAR** operator creates *in the data block* either a turbine object or a compressor object, which can be coupled with the **SHAFT** operator.

For each model (turbine or compressor), the user can specify either pressure ratio and isentropic efficiency data, or head and torque data. In each case the data can be given either directly in the input data deck, or by using a library.

The TCOMCHAR is located on a current vector mesh of an axial element.

The TCOMCHAR is automatically connected when it is defined.

### Associated Keywords

STARSLURG, STOPSLURG, TCOMMOD, VALUE FOR TCOMCHAR, WRITE FOR TCOMCHAR

### Syntax

## 224.1 TURBINE modeling

### 224.1.1 TURBINE modeling using specified pressure ratio and isentropic efficiency data

```
char =      TCOMCHAR elem      pi      TURB
```

```
|| LIBRARY      libname
```

or

```
|| LIBRARY      FILE      'FILENAME'
```

or

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 633/851</a>

<b>OMEGPIT</b>	omp1	...	ompn
<b>FLOWPIT</b>	flp1	...	flpm
<b>PITSTAR</b>	pit(omp1, flp1)		
	...		
	pit(omp1, flpm)		
	...		
	pit(ompn, flp1)		
	...		
	pit(ompn, flpm)		
	...		
<b>OMEGETAT</b>	ome1	...	omen
<b>FLOWETAT</b>	fle1	...	flem
<b>ETATSTAR</b>	eta(ome1, fle1)		
	...		
	eta(ome1, flem)		
	...		
	eta(omen, fle1)		
	...		
	eta(omen, flem)		

<b>PITREF</b>	z11
<b>ETATREF</b>	z12

<b>(METHOD</b>	<b>LEASTSQ</b>		
	<b>DEGRPI</b>	d1	
	<b>DEGRETA</b>	d2 )	
<b>METHOD</b>	<b>BICUBSPL</b>	or	<b>BIHARSPL</b>
	<b>DISCPI</b>	d1	
	<b>DISCETA</b>	d2	

or

<b>INERTIA</b>	z1			
<b>VELOCITY</b>	<b>ROTATION</b>	<b>RPM</b>	z2	
or	<b>ROTATION</b>	<b>RADSEC</b>	z3	
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RPM</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RADSEC</b>	lawj
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>NORMAL</b>	z4
				lawj
<b>NOMV</b>	z5			
<b>NOMFLOW</b>	z6			
<b>EXPANSIO</b>	z10			
<b>(RCONST</b>	z11)			
<b>(PDEF</b>	z12)			
<b>TDEF</b>	z13			
<b>(MUDEF</b>	z14)	;		

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 634/851

## 224.1.2 TURBINE modeling using specified head and torque data

char=            **TCOMCHAR** elem            pi            **TURB**

<b>HCOEFF</b>	h1 .... h10
<b>TCOEFF</b>	t1 .... t10
<b>GRAVH</b>	g1
<b>NOMTORQ</b>	n1

or

<b>LIBRARY</b>	libname
----------------	---------

or

<b>LIBRARY</b>	‘FILENAME’
<b>FILE</b>	

or

<b>OMEGHEAD</b>	omh1            ...	omhn
<b>FLOWHEAD</b>	flh1            ...	flhm
<b>HEADSTAR</b>	head(ome1, flh1)	
	...	
	head(ome1, flhm)	
	...	
	head(omen, flhl)	
	...	
	head(omen, flhm)	
 <b>OMEGTORQ</b>	 omt1            ...	 omtn
<b>FLOWTORQ</b>	flt1            ...	fltm
<b>TORQSTAR</b>	torq(omp1, flt1)	
	...	
	torq(omp1, fltm)	
	...	
	torq(ompn, flt1)	
	...	
	torq(omp1, fltm)	

<b>GRAVH</b>	g1
<b>NOMTORQ</b>	n1

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 635/851

```

|| ( METHOD    LEASTSQ
     DEGRHEAD d1
     DEGRTORQ d2 )
or
METHOD    BICUBSPL   or      BIHARSPL
DISHEAD   d1
DISCTORQ  d2

INERTIA    z1
VELOCITY   ROTATION  RPM      z2
or          ROTATION   RADSEC   z3
or          ROTATION   IMPOSED  RPM      lawj
or          ROTATION   IMPOSED  RADSEC   lawj
or          ROTATION   IMPOSED  NORMAL   z4           lawj
NOMV       z5
NOMFLOW    z6

EXPANSIO   z10
(RCONST    z11)
(PDEF      z12)
(TDEF      z13)
(MUDEF    z14)      ;

```

## 224.2 COMPRESSOR modeling

### 224.2.1 COMPRESSOR modeling using specified pressure ratio and isentropic efficiency data

char=           **TCOMCHAR** elem           pi           **COMP**

```

|| LIBRARY    libname

```

or

```

|| LIBRARY    'FILENAME'
|| FILE

```

or

```

|| OMEGPIC    omp1      ...      ompn
|| FLOWPIC    flp1      ...      flpm

```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 636/851

<b>PICSTAR</b> <b>FLOWETAC</b> <b>ETACSTAR</b>	pic(omp1, flp1) ... pic(omp1, flpm) ... pic(ompn, flp1) ... pic(ompn, flpm) <b>OMEGETAC</b> ome1 fle1 ... Flem eta(ome1, fle1) ... eta(ome1, flem) ... eta(omen, fle1) ... eta(omen, flem)	... omen
--	---	-------------

	<b>PICREF</b>	z11			
	<b>ETACREF</b>	z12			

<b>(METHOD</b> <b>or</b> <b>METHOD</b>	<b>LEASTSQ</b> <b>DEGRPI</b> d1 <b>DEGRETA</b> d2 )			
		<b>BICUBSPL</b>	<b>BIHARSPL</b>	
		<b>DISCPI</b> or d1		
		<b>DISCETA</b> d2		

<b>INERTIA</b>	z1				
<b>MOTOR</b>	<b>TORQUE</b>	<b>CALCULCR</b>	<b>tc1</b>	<b>tc2</b>	<b>tc3</b>
or	<b>TORQUE</b>	<b>IMPOSEC</b>	<b>tc1</b>	<b>tc2</b>	
or			<b>tc3</b>	<b>tc4</b>	
or	<b>NOTORQUE</b>				
<b>(FRICTION</b>	fr1	fr2	fr3	fr4)	
<b>VELOCITY</b>	<b>RPM</b>	z12			
or	<b>RADSEC</b>	z13			
or	<b>ROTATION</b>	<b>RPM</b>	z2		
or	<b>ROTATION</b>	<b>RADSEC</b>	z3		
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RPM</b>	lawj	
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>RADSEC</b>	lawj	
or	<b>ROTATION</b>	<b>IMPOSED</b>	<b>NORMAL</b>	z4	lawj
<b>NOMV</b>	z5				
<b>NOMFLOW</b>	z6				
<b>EXPANSIO</b>	z10				
<b>(RCONST</b>	z11)				

 <small>DE LA RECHERCHE À L'INDUSTRIE</small>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 637/851</a>

(PDEF z12)  
**TDEF** z13  
(MUDEF z14)

<b>MAPSURGE</b>	<b>OMEGSURG</b>	oms1	...	omsm
	<b>FLOWSURG</b>	h(oms1)	...	h(omsm)
	<b>REFSURGE</b>	z11		
	<b>DEGRSURG</b>	d3	;	

## 224.2.2 COMPRESSOR modeling using specified head and torque data

char=           **TCOMCHAR** elem           pi           **COMP**

<b>HCOEFF</b>	h1	...	h10
<b>TCOEFF</b>	t1	...	t10
<b>GRAVH</b>	g1		
<b>NOMTORQ</b>	n1		

or

<b>LIBRARY</b>	libname
----------------	---------

or

<b>LIBRARY</b>	‘FILENAME’
<b>FILE</b>	

or

<b>OMEGHEAD</b>	omh1	...	omhn
<b>FLOWHEAD</b>	flh1	...	flhm
<b>HEADSTAR</b>	head(ome1, flh1)		
	...		
	head(ome1, flhm)		
	...		
	head(omen, flh1)		
	...		
	head(omen, flhm)		
<b>OMEGTORQ</b>	omt1	...	omtn
<b>FLOWTORQ</b>	flt1	...	fltm
<b>TORQSTAR</b>	torq(omp1, flt1)		

<b>DE LA RECHERCHE À L'INDUSTRIE</b> 	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 638/851</a>

...
   
 torq(omp1, fltm)
   
 ...
   
 torq(ompn, flt1)
   
 ...
   
 torq(ompn, fltm)

**GRAVH** g1  
**NOMTOR** n1

<b>(METHOD</b> <b>DEGRHEAD</b> d1 <b>DEGRTORQ</b> d2 ) or <b>METHOD</b>	<b>LEASTSQ</b> <b>BICUBSPL</b> or <b>BIHARSPL</b> <b>DISHEAD</b> d1 <b>DISCTORQ</b> d2
---	---

<b>INERTIA</b> z1 <b>MOTOR</b> TORQUE or TORQUE or or <b>NOTORQUE</b> <b>(FRICTION</b> fr1 fr2 fr3 fr4) <b>VELOCITY</b> RPM z12 or RADSEC z13 or ROTATION RPM z2 or ROTATION RADSEC z3 or ROTATION IMPOSED RPM lawj or ROTATION IMPOSED RADSEC lawj or ROTATION IMPOSED NORMAL z4 lawj <b>NOMV</b> z5 <b>NOMFLOW</b> z6  <b>EXPANSIO</b> z10 <b>(RCONST</b> z11) <b>(PDEF</b> z12) <b>TDEF</b> z13 <b>(MUDEF</b> z14)  <b>MAPSURGE</b> OMEGSURG oms1 ... omsm FLOWSURG h(oms1) ... h(omsm) REFSURGE z11  <b>DEGRSURG</b> d3 ;
---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 639/851

**elem** : axial element name  
**pi** : vector point to which the turbine or the compressor is to be assigned.

### 1. Only for “pressure ratio and isentropic efficiency” data specification

**LIBRARY** : keyword indicating that a predefined library is used. This is followed by :  
**libname** : keyword defining the type of the TCOMCHAR.

Two types of library are available:

- (a) Private libraries: predefined characteristics are included in following typename  
**TCOMCHARS** : **TGTMHR** (for GT-MHR turbine type), **CGTMHR** (for GT-MHR compressor type),
- (b) User’s librairies : **TLIBUSER**<sup>1</sup> (for user’s turbine type), **CLIBUSER**<sup>1</sup> (for user’s compressor type).

**LIBRARY FILE** : keywords indicating that a library predefined in a file is used. This is followed by :  
**‘FILENAME’** : keyword defining the name of the library that should be used for the given turbomachine. The filename must be 8 characters long. Predefined characteristics are then read in file ‘FILENAME.MAP’<sup>2</sup>

### 2. Case of a TURBINE (TURB): only mandatory when no library is used.

**OMEGPIT** : keyword indicating that the reduced rotational speed values are given. This is followed by:  
**omp1 ... opn** : n real numbers representing the reduced rotational speed values.

**FLOWPIT** : keyword indicating that the reduced flow rate values are given. This is followed by:  
**fip1 ... fpm** : m real numbers representing the reduced flow rate values.

**PITSTAR** : keyword indicating that the reduced expansion ratio values in function of reduced rotational speed values and reduced flow rate values are given. This is followed by:  
**pit(omp1,fip1)  
...pit(opn,fpm)** : m\*n real numbers representing reduced expansion ratio values.

**OMEGETAT** : keyword indicating that the reduced rotational speed values are given. This is followed by:  
**ome1 ... omen** : n real numbers representing the reduced rotational speed values.

**FLOWETAT** : keyword indicating that the reduced flow rate values are given . This is followed by:  
**fle1 ... flem** : m real numbers representing the reduced flow rate values.

<sup>1</sup>In case of users’s library, LIBTCUSE subroutine must be defined. A new compilation of the READER is mandatory

<sup>2</sup>In case of USER FILE library, “FILENAME.MAP” file must be written (format description given in subroutine LIBTCFIL.f). Be careful that the tabulation character is forbidden in the file.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 640/851

**ETATSTAR** : keyword indicating that the reduced efficiency values in function of designed reduced rotational speed values and designed reduced flow rate values are given. This is followed by:  
**eta(ome1,fle1)** ... : m\*n real numbers representing reduced efficiency values.  
**eta(omen,flem)**

**PITREF z11** : keyword followed by a real number > 0., representing the reference expansion ratio. In standard working, the expansion ratio will have to be > 1.

**ETATREF z12** : keyword followed by a real number > 0., representing the reference efficiency.

**METHOD** : keyword followed by the name of the mapping method that must be used. Available methods are the following (If keyword METHOD is missing, then LEASTSQ method is used) :

- 1)  
**LEASTSQ** : least square polynomial approximation of data will be used.  
**DEGRPI d1** : keyword followed by an integer  $2 \leq d1 \leq 6$  defining the degree of the reduced expansion ratio polynomial  
**DEGRETA d2** : keyword followed by an integer  $2 \leq d2 \leq 6$  defining the degree of the reduced efficiency polynomial
- 2)  
**BICUBSPL** : bicubic spline interpolation of data will be used.  
**or BIHARSPL** : biharmonic spline interpolation of data will be used.  
**DISCPI d1** : keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced expansion ratio mapping  
**DISCETA d2** : keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced efficiency mapping

### 3. Case of a **COMPRESSOR (COMP)** : only mandatory when no library is used.

**OMEGPIC** : keyword indicating that the reduced rotational speed values are given. This is followed by:  
**omp1 ... opn** : n real numbers representing the reduced rotational speed values.

**FLOWPIC** : keyword indicating that the reduced flow rate values are given. This is followed by:  
**fip1 ... fpm** : m real numbers representing the reduced flow rate values.

**PICSTAR** : keyword indicating that the reduced compression ratio values in function of reduced rotational speed values and reduced flow rate values are given. This is followed by:  
**pit(omp1,fip1)** ... **pit(opn,fpm)** : m\*n real numbers representing reduced compression ratio values.

**OMEGETAC** : keyword indicating that the reduced rotational speed values are given. This is followed by:  
**ome1 ... omen** : n real numbers representing the reduced rotational speed values.

**FLOWETAC** : keyword indicating that the reduced flow rate values are given. This is followed by:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 641/851

<b>fle1 ... flem</b>	: m real numbers representing the reduced flow rate values.
<b>ETACSTAR</b>	: keyword indicating that the reduced efficiency values in function of reduced rotational speed values and reduced flow rate values are given. This is followed by:
<b>eta(ome1,fle1)</b>	... : m*n real numbers representing reduced efficiency values.
<b>eta(omen,flem)</b>	
 <b>PICREF z11</b>	: keyword followed by a real number > 0., representing the reference compression ratio. In standard working, the compression ratio will have to be > 1.
<b>ETACREF z12</b>	: keyword followed by a real number > 0., representing the reference efficiency.
 <b>METHOD</b>	: keyword followed by the name of the mapping method that must be used. Available methods are the following (If keyword METHOD is missing, then LEASTSQ method is used) :
<b>1)</b>	
<b>LEASTSQ</b>	: Least square polynomial approximation of data will be used.
<b>DEGRPI d1</b>	: Keyword followed by an integer $2 \leq d1 \leq 6$ defining the degree of the reduced compression ratio polynomial.
<b>DEGRETA d2</b>	: Keyword followed by an integer $2 \leq d2 \leq 6$ defining the degree of the reduced efficiency polynomial.
<b>2)</b>	
<b>BICUBSPL</b>	: bicubic spline interpolation of data will be used.
<b>or BIHARSPL</b>	: biharmonic spline interpolation of data will be used.
<b>DISCHPI d1</b>	: Keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced compression ratio mapping.
<b>DEGRETA d2</b>	: Keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced efficiency mapping.

#### 4. Only for “head and torque” data specification :

<b>HCOEFF</b>	: keyword indicating that the coefficients of the head interpolation law used for reduced form $\frac{H}{H_{ref}}$ are given. This is followed by :
<b>h1 ... h10</b>	: 10 real numbers representing the coefficients of the reduced head interpolation function.
<p>The 2 variables of the polynomial are <math>x = \frac{q}{q_{ref}}</math> (reduced flow rate) and <math>y = \frac{\omega}{\omega_{ref}}</math> (reduced rotational speed). The polynomial is :</p> $\frac{H}{H_{ref}} = h1 + h2.x + h3.y + h4.x^2 + h5.y^2 + h6.xy + h7.x^3 + h8.y^3 + h9.xy^2 + h10.x^2y$	
<b>TCOEFF</b>	: keyword indicating that the coefficients of the torque interpolation law used for reduced form $\frac{t}{t_{ref}}$ are given. This is followed by :
<b>t1 ... t10</b>	: 10 real numbers representing the coefficients of the reduced torque interpolation function.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 642/851

The 2 variables of the polynomial are  $x = \frac{q}{q_{ref}}$  (reduced flow rate),  $y = \frac{\omega}{\omega_{ref}}$  (reduced rotational speed). The polynomial is :

$$\frac{t}{t_{ref}} = t1 + t2.x + t3.y + t4.x^2 + t5.y^2 + t6.xy + t7.x^3 + t8.y^3 + t9.xy^2 + t10.x^2y$$

or

#### **LIBRARY**

**libname**

: keyword indicating that a predefined library is used. This is followed by :

: keyword defining the type of the TCOMCHAR.

Two types of library are available:

- (a) Private libraries: predefined characteristics are included in following typname  
TCOMCHARS : **TGTMHR** (for GT-MHR turbine type), **CGTMHR** (for GT-MHR compressor type),
- (b) User's librairies : **TLIBUSER**<sup>1</sup> (for user's turbine type), **CLIBUSER**<sup>1</sup> (for user's compressor type).

#### **LIBRARY FILE**

: keywords indicating that a library predefined in a file is used. This is followed by :

#### **'FILENAME'**

: keyword defining the name of the library that should be used for the given turbomachine. The filename must be 8 characters long. Predefined characteristics are then read in file "FILENAME.MAP"<sup>2</sup>

Or

#### **OMEGLHEAD**

: keyword indicating that the reduced rotational speed values are given. This is followed by:

: n real numbers representing the reduced rotational speed values.

#### **FLOWHEAD**

**fh1 ... flhm**

: keyword indicating that the reduced flow rate values are given. This is followed by:

: m real numbers representing the reduced flow rate values.

#### **HEADSTAR**

: keyword indicating that the reduced head values in function of reduced rotational speed values and reduced flow rate values are given. This is followed by:

: m\*n real numbers representing reduced head values.

**head(omh1,fh1)  
...head(omhn,flhm)**

#### **OMEGLTORQ**

: keyword indicating that the reduced rotational speed values are given . This is followed by:

: n real numbers representing the reduced rotational speed values.

**omt1 ... omtm**

#### **FLOWTORQ**

**ft1 ... ftm**

: keyword indicating that the reduced flow rate values are given . This is followed by:

: m real numbers representing the reduced flow rate values.

#### **TORQSTAR**

: keyword indicating that the reduced torque values in function of designed reduced rotational speed values and designed reduced flow rate values are given. This is followed by:

<sup>1</sup>In case of user's library, LIBTCUSE subroutine must be defined. A new compilation of the READER is mandatory.

<sup>2</sup>In case of USER FILE library, "FILENAME.MAP" file must be written (format description given in subroutine LIBTCFIL.f). Be careful that the tabulation character is forbidden in the file.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 643/851

**torq(omt1,flt1) ...** : m\*n real numbers representing reduced torque values.  
**torq(omtn,fltm)**

**GRAVH g1** : keyword followed by a real number (positive for a compressor and negative for a turbine), representing the nominal head multiplied by gravity ( $m^2/s^2$ ).  
**NOMTORQ n1** : keyword followed by a real number (positive for a compressor and negative for a turbine), representing the nominal specific torque ( $m^5/s^2$ ).  
**NB** : Specific torque = torque/specific mass.

**METHOD** : keyword followed by the name of the mapping method that must be used. Available methods are the following (If keyword METHOD is missing, then LEASTSQ method is used) :

1)  
**LEASTSQ** : least square polynomial approximation of data will be used.  
**DEGRHEAD d1** : keyword followed by an integer  $2 \leq d1 \leq 6$  defining the degree of the reduced head polynomial.  
**DEGRTORQ d2** : keyword followed by an integer  $2 \leq d2 \leq 6$  defining the degree of the reduced torque polynomial.

2)  
**BICUBSPL** : bicubic spline interpolation of data will be used.  
**or BIHARSPL** : biharmonic spline interpolation of data will be used.  
**DISCHEAD d1** : keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced head mapping.  
**DEGRTORQ d2** : keyword followed by an integer defining the number of reduced flow discretization points that will be used for the reduced torque mapping.

##### 5. For any data specification :

The following keywords are available either for a TURBINE or for a COMPRESSOR :

**INERTIA z1** : keyword followed by a real number  $> 0.$ , representing the inertia of the motor in ( $kg.m^2$ ).  
**MOTOR** : Available for a compressor only. Optional keyword indicating that an electrical motor is defined and his that is data are to be read. This is followed by:  
**TORQUE** : keyword indicating that the coefficients of the motor torque function are to be read. This is followed by :  
**CALCULCR** : keyword indicating that the motor torque multiplier is calculated by the code after the steady state. This is followed by:  
**tc1 tc2 tc3** : real numbers representing the coefficients of the motor torque function and depending on voltage.  
**IMPOSECR** : keyword indicating that the motor torque multiplier is given. This option is used when for example, the steady state computation is performed with a compressor rotation velocity equal to zero. This is followed by:  
**tc1 tc2 tc3 tc4** : real numbers representing the coefficients of the motor torque function and depending on voltage : real number representing the motor torque multiplier.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 644/851

**NB :** The torque applied on the shaft by the motor for asynchronous motors is classically given by the reduced formula:

$$Cm = \frac{Cr \cdot g \cdot (tc1 + tc2 \cdot G)}{((tc3 \cdot g)^2 + (tc1 + tc2 \cdot G)^2)} = Cr \cdot F(g) = tc4 \cdot F(g)$$

With :  $Cm$  = motor torque

$Cr$  = nominal motor torque multiplier

- (a) calculated by the code after the steady state (CALCULCR) :  $Cr = \frac{Cf + Ch}{F(g)}$  with  $Cf$  and  $Ch$  friction and hydraulic torque respectively,
- (b) or given by the user (IMPOSECR)  $g$  (dynamic slip),  $g = 1 - \frac{om}{oms}$ ,  $om$  = pump rotation speed,  $oms$  = synchronism velocity (for example 1500 rpm)  $G = |g|$

#### **or NOTORQUE**

: keyword indicating that the coefficients of the motor torque function are not given. In this case, the rotation speed must be imposed on a steady basis throughout the entire transient computation. Furthermore, no computation of pump rotation speed may be performed. This option corresponds to the default option (no electrical motor is defined).

#### **FRICITION**

: Available for a compressor only. Optional keyword indicating that the coefficients of an additional friction torque law, included in the shaft equation only, are given. This is followed by:

: four real numbers representing the friction coefficients.

**NB :** The friction torque  $Cf$  :  $Cf = fr1 + fr2 \cdot OM + fr3 \cdot OM \cdot |OM| + fr4 \cdot Pressure$  in which  $OM$  is the rotation speed (rad/s),  $Cf$  (Nm),  $Pressure$  (Pa).

#### **VELOCITY**

##### **RPM**

: keyword indicating that the imposed velocity values are given. This is followed by:

: Available for a compressor only : keyword indicating that the electrical motor synchronism speed for the transient computation is given in (rpm). This keyword (or RADSEC) is necessary if an electrical motor has been defined. This is followed by:

: real number  $\geq 0$ ., representing the synchronism speed (rpm).

##### **z12**

or

##### **RADSEC**

: Available for a compressor only : keyword indicating that the electrical motor synchronism speed for the transient computation is given in (rad/s). This keyword (or RPM) is necessary if an electrical motor has been defined. This is followed by:

: real number  $\geq 0$ ., representing the synchronism speed (rad/s).

##### **z13**

or

##### **ROTATION**

: keyword indicating that the pump rotational speed for the steady computation or for the transient computation is imposed. This keyword is used when no electrical motor has been defined. This is followed by:

: keyword indicating that the velocity values in (rpm) are given. This is followed by:

: real number  $\geq 0$ ., representing the rotational speed (rpm).

##### **RPM**

##### **z2**

or

##### **RADSEC**

: keyword indicating that the velocity values in (rad/s) are given. This is followed by:

: real number  $> 0$ ., representing the rotational speed (rad/s).

##### **z3**

or

##### **IMPOSED**

: keyword indicating that a law governing rotational speed as a function of time is defined. This is followed by:

: keyword indicating that the user wishes to read the ‘TIME’ ‘ROTV’ law governing rotational speed (RPM) as a function of time. This is followed by:

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 645/851

<b>lawj</b> or <b>RADSEC</b> <b>lawj</b> or <b>NORMAL</b> <b>z4</b> <b>lawj</b> <b>NOMV z5</b> <b>NOMFLOW z6</b> <b>EXPANSIO z10</b> <b>RCONST z11</b> <b>PDEF z12</b> <b>TDEF z13</b> <b>MUDEF z14</b>	<p>: law object defining the evolution of the rotational speed as a function of time. The number of points in the law is limited to 100.</p> <p>: keyword indicating that the “TIME” ‘ROTV’ law governing rotational speed (rad/s) as a function of time. This is followed by:</p> <p>: law object defining the evolution of the rotational speed as a function of time. The number of points in the law is limited to 100.</p> <p>: keyword indicating that the normalized “TIME’ ‘ROTV’ law governing the evolution of the rotational speed as function of time is defined. This is followed by:</p> <p>: normalization coefficient for speed rotational. This is followed by:</p> <p>: law object defining the evolution of the rotational speed as a function of time. The number of points in the law is limited to 100.</p> <p><u>For “head and torque” data specification:</u> keyword followed by a real number, representing the reference velocity in (rpm)</p> <p><u>For “pressure ratio and isentropic efficiency” data specification :</u> keyword followed by a real number, representing the reduced reference velocity, calculated as follow:  <math display="block">\frac{OM}{SQRT(T_{in})} \text{ ref}</math></p> <p><u>For “head and torque” data specification:</u> keyword followed by a real number, representing the reference volumetric flow rate in (<math>\text{m}^3/\text{s}</math>).</p> <p><u>For “pressure ratio and isentropic efficiency” data specification:</u> keyword followed by a real number, representing the reduced reference flow rate, calculated as follow:  <math display="block">\frac{Q \cdot SQRT(T_{in})}{P_{in}} \text{ ref}</math></p> <p><math>(T_{in}, P_{in})</math> characteristics of considered element.</p> <p>: keyword followed by a real number <math>&gt; 0</math>., representing the ratio of specific heats.</p> <p>: OPTIONAL keyword followed by a real number <math>&gt; 0</math>., representing the reference gas constant. (J/kg/K)</p> <p>: OPTIONAL keyword followed by a real number <math>&gt; 0</math>., representing the reference pressure (in Pa)</p> <p>: keyword followed by a real number <math>&gt; 0</math>., representing the reference temperature (<math>^{\circ}\text{C}</math>).</p> <p>: OPTIONAL keyword followed by a real number <math>&gt; 0</math>., representing the reference dynamic viscosity (<math>\text{kg} \cdot \text{m}^{-1} \cdot \text{s}^{-1}</math>)</p>
---	---

## 6. The following keywords are only available for a COMPRESSOR :

<b>MAPSURGE<sup>3</sup></b> <b>OMEGSURG</b> <b>oms1 ... omsm</b> <b>FLowsurg</b> <b>h(oms1) ... h(omsm)</b> <b>REFSURG z11</b> <b>DEGRSURG d3</b>	<p>: keyword indicating that the information about surge limits are given. This is followed by :</p> <p>: keyword indicating that the reduced rotational speed values are given. This is followed by:</p> <p>: m real numbers representing the reduced rotational speed values.</p> <p>: keyword indicating that the reduced flow rate values are given. This is followed by:</p> <p>: m real numbers representing the reduced flow rate values.</p> <p>: keyword followed by a real number <math>&gt; 0</math>., representing the reduced pumping flow rate.</p> <p>: LESATSQ use only (see keyword METHOD) Keyword followed by an integer <math>2 \leq d3 \leq 5</math> defining the degree of the pumping flow rate polynomial.</p>
---	--

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 646/851

<b>Examples</b>
-----------------

**1. Turbine:** Head and torque data (polynomial coefficients)

```

AXTURB = AXIAL      ... ;
*PT2: vector point of AXTURB
LOITURB = LAW        'TIME'      'ROTV'
           0.          2000.
           TSUP        2000. ;

*NNTURB: numerical value
TURB1 =  TCOMCHAR   AXTURB    PT2 TURB
        HCOEFF     0.06D0    0.001D0   1.2D0    -3.5D0
                  0.4D0     -1.1D0    0.8D0    -0.3D0
                  0.07D0    2.1D0
        TCOEFF     0.12D0    1.45D0    0.93D0   -0.6D0
                  2.6D0     1.49D0   -1.2D0   -0.96D0
                  0.22D0   -3.7D0

        GRAVH     1463436.19
        NOMTORQ   NNTURB
        INERTIA    4.10D3
        VELOCITY   ROTATION   IMPOSED    RPM       LOITURB
        NOMV       3000.
        NOMFLOW   104.40
        MASSVOL   3.04
        EXPANSIO  1.666667
        TDEF       848.4 ;

```

**2. Turbine:** Head and torque data (data given in a library)

```

TUYTURB1= AXIAL      ...
PT7 : vector point of TUYTURB1
LOITURB = LAW        'TIME'      'ROTV'
           0.          2000.
           TSUP        2000. ;

NOMTORQT NOMVT NOMFLOWT: numerical values
TLIBUSER: name of the user's library (TLIBUSER.MAP file)
TURB1 =  TCOMCHAR   TUYTURB1  PT7      TURB
        LIBRARY     FILE      'TLIBUSER'
        GRAVH      3.47D5
        NOMTORQ   NOMTORQT
        METHOD     BICUBSPL
                  DISCHEAD  80
                  DISCTORQ 80
        INERTIA    4000.
        VELOCITY   ROTATION  IMPOSED    RPM       LOITURB
        NOMV       NOMVT
        NOMFLOW   NOMFLOWT
        EXPANSIO  2.1
        TDEF       700. ;

```

<sup>3</sup>MAPSURGE characteristics are also functions of TDEF and REFV(and PICREF)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 647/851

3. **Turbine:** Compression rate and efficiency data (data given in a library)

```

TUYTURB1= AXIAL ...
PT7 : vector point of TUYTURB1
LOITURB = LAW      'TIME'      'ROTV'
          0.        2000.
          TSUP       2000. ;
ETATREFv PITREFv NOMVT NOMFLOWT: numerical values
TLIBUSER: name of the user's library (TLIBUSER.MAP file)
TURB1 =   TCOMCHAR  TUYTURB1  PT7           TURB
LIBRARY    FILE      'TLIBUSER'
          PITREF    PITREFv
          ETATREF   ETATREFv
          METHOD    BICUBSPL
          DISCHEAD  80
          DISCTORQ  80
          INERTIA   4000.
          VELOCITY  ROTATION  IMPOSED    RPM
          NOMV      NOMVT
          NOMFLOW   NOMFLOWT
          EXPANSIO  2.1
          TDEF      700. ;

```

4. **Compressor:** Compression rate and efficiency data (data given in a library)

```

TUYCOMP1= AXIAL ...
PC1 : vector point of TUYCOMP1
LOICHP = LAW      'TIME'      'ROTV'
          0.        1000.
          TSUP       1000. ;
PICREFC NOMVCT NOMFLOWC numerical values
CLIBUSER: name of the user's library (CLIBUSER.MAP file)
COMPRE1=   TCOMCHAR  TUYCOMP1  PC1           COMP
          LIBRARY    FILE      'CLIBUSER'
          PICREF    PICREFC
          ETACREF   0.615
          METHOD    BICUBSPL
          DISCHEAD  120
          DISCTORQ  120
          INERTIA   6270.
          VELOCITY  ROTATION  IMPOSED    RPM
          NOMV      NOMVC
          NOMFLOW   NOMFLOWC
          EXPANSIO  1.1017
          TDEF      25.2 ;

```

5. **Compressor:** Head and torque data (data given in a library)

```

TUYCOMP1= AXIAL ...
PC1: vector point of TUYCOMP1

```

 DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 648/851

LOICHP = LAW            'TIME'            'ROTV'  
               0.            1000.  
               TSUP            1000. ;

GRAVHC NOMTORQC NOMVCT NOMFLOWC: numerical values

CLIBUSER: name of the user's library (CLIBUSER.MAP file)

COMPRE1= **TCOMCHAR** TUYCOMP1 PC1            **COMP**  
           LIBRARY FILE            'CLIBUSER'  
           GRAVH GRAVHC  
           NOMTORQ NOMTORQC  
           METHOD BICUBSPL  
                   DISCHEAD 120  
                   DISCTORQ 120  
           INERTIA 6270.  
           VELOCITY ROTATION IMPOSED RPM            LOICHP  
           NOMV NOMVC  
           NOMFLOW NOMFLOWC  
           EXPANSIO 1.1017  
           TDEF      25.2 ;

#### 6. Compressor: Driven by a motor - Head and torque data (data given in a library)

CIRCU1= AXIAL ...  
 P2CIRCU: vector point of TUYTURB1  
 LOITURB = LAW            'TIME'            'ROTV'  
               0.            2000.  
               TSUP            2000. ;

GRAVHP NOMTORQP WCIRCUS NOMFLOWP TICIRCU: numerical values

GPOMPCSP: name of the user's library (GPOMPCSP.MAP file)

POMPE1= **TCOMCHAR** CIRCU1 P2CIRCU            **COMP**  
           LIBRARY FILE            'GPOMPCSP'  
           GRAVH GRAVHP  
           NOMTORQ NOMTORQP  
           METHOD BIHARSPL  
                   DISCHEAD 200  
                   DISCTORQ 200  
           INERTIA 130.  
           **MOTOR** TORQUE IMPOSECR 7.998D-3 3.915E-2 0.1591  
           COUPMPM  
           FRICTION 74.25 0.1576 0. 0.  
           VELOCITY RPM WCIRCUS  
           NOMV WCIRCUS  
           NOMFLOW NOMFLOWP  
           EXPANSIO 1.6667  
           TDEF      TICIRCU ;

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 649/851

225

## TCOMMOD DIRECTIVE

The **TCOMMOD** directive is used to modify the characteristics of a **TCOMCHAR** (turbine or compressor) during a transient, in the *command block*.

### Associated Keywords

**TCOMCHAR, STARSURG, STOPSURG**

### Syntax

<b>TCOMMOD</b>	char	<b>ROTATION</b>
<b>RPM</b>		<b>ABSOLUTE</b> list1
	or	<b>RELATIVE</b> list1
		<b>ROTV</b> list2 ;
or		
<b>RADSEC</b>		<b>ABSOLUTE</b> list1
	or	<b>RELATIVE</b> list1
		<b>ROTV</b> list2 ;
or		
<b>NORMAL z7</b>		<b>ABSOLUTE</b> list1
	or	<b>RELATIVE</b> list1
		<b>ROTV</b> list2 ;
or		
<b>TCOMMOD</b>	char	<b>CALROTA</b> ;
	or	<b>CALROTA</b> <b>STARTCMO</b> ;
	or	<b>CALROTA</b> <b>STOPTCMO</b> ;
	or	<b>CALROTA</b> <b>STOPTCMO</b> <b>BLOCKED</b> ;
or		
<b>TCOMMOD</b>	char	<b>INERTIA</b> z1 ;

**char** : name of the considered tcomchar object the characteristics of which will be modified.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 650/851

<b>ROTATION</b>	: keyword indicating that the tcomchar rotational speed is imposed. This is followed by:
<b>RPM</b>	: keyword indicating that the rotational speed values will be given in (rpm).
or <b>RADSEC</b>	: keyword indicating that the rotational speed values will be given in (rad/s).
or <b>NORMAL z7</b>	: keyword indicating that the rotational speed values are going to be normalised. It is followed by : normalisation coefficient for speed rotation.
<b>ABSOLUTE</b>	: keyword used for defining the absolute time in the TCOMCHAR velocity variation law. If the relative time is considered, the keyword ABSOLUTE will be replaced by the keyword RELATIVE.
<b>List1</b>	: list defined with the keyword REALLIST followed by a list of time values.
<b>ROTV</b>	: keyword specifying that the TCOMCHAR velocity values are to be given.
<b>List2</b>	: list defined with the keyword REALLIST followed by the velocity variations function of time.
<b>CALROTA</b>	: keyword indicating that the rotational speed is calculated, instead of being imposed. This option is used when, for example after performing a stable state calculation by transient with regulations, the user wants to calculate the rotational speed and not to impose it anymore.
<b>STARTCMO</b>	: <u>Available for a compressor only</u> : Optional keyword indicating that the electrical motor torque is going to be calculated. This option is used when, for example, the user wants to start up a compressor after it has been stopped using STOPTCMO option.
or <b>STOPTCMO</b>	: <u>Available for a compressor only</u> : Optional keyword indicating that the electrical motor torque is switched off. This option is used when the user wants to stop a compressor and to calculate the decrease of its rotational speed.
<b>BLOCKED</b>	: Optional keyword indicating that the electrical motor torque is switched off and that the rotational speed is set to zero. This option is used when, for example, the steady state computation must be performed with a zero rotational speed because the compressor is stopped at the beginning of the transient .
<b>INERTIA z1</b>	: Keyword followed by a real number = 0 to impose a new value for the inertia of the compressor or turbine (in kg.m <sup>2</sup> )

### Example

```

TCOMMOD   compre1      ROTATION    RPM
          ABSOLUTE
          REALLIST   x1        x2        ...
          ROTV
          REALLIST   y1        y2        ...
                               ...      xn
                               ;       yn ;

TCOMMOD   compre2      CALROTA   ;
TCOMMOD   compre3      CALROTA   STOPTCMO  BLOCKED   ;
TCOMMOD   compre3      CALROTA   STARTCMO  ;
TCOMMOD   compre3      CALROTA   STOPTCMO  ;
TCOMMOD   compre3      INERTIA   1.D3 ;

```

**NB :** This directive generates several calls to the FORTRAN subroutines RTCMOD2, RTCMOD3.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 651/851

# 226

## TEE OPERATOR

The **TEE** operator creates a Tee-branch in the *data block*. In the V2.5 version series, the Tee-branch is not a separate element and it should be seen as a lateral junction on the side of a pipe ; therefore, it has **to be linked to an axial element**. (see **CONNECT** directive).

### Associated Keywords

**CONNECT, GEOM, SINGULAR**

### Syntax

```
elem =           TEE           junc1           sens1           ;
```

<b>elem</b>	: Tee-branch name
<b>junc1</b> <b>sens1</b>	: junction name followed by a keyword defining the orientation of the junction in the element. This keyword is <b>UPSTREAM</b> or <b>DSTREAM</b> <sup>1</sup> .

### Example

```
tepressu =      TEE txpansr   DSTREAM     ;
```

---

<sup>1</sup>The choice is insignificant since you have controlled that for the other element related to this junction, the other keyword is used.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 652/851

227

## THREED OPERATOR

The **THREED** operator creates a 3D element in the *data block* by defining its topology.

The definition of the THREED geometry, meshing, connections to others elements will be achieved by the use of 7 directives:

1. 4 compulsory directives : **MESH**, **GEOM**, **PHYSCALE**, **CONNECT** relative to the **3-D** meshing, geometry, length scales and topology.
2. 3 optional directives : **HYDR**, **TURBULEN**, **SINGULAR** relative to the **3-D** flow pattern.

The discretization and mesh numbering of a 3D elements is described in the CATHARE2 User's Manuel document.

### Associated Keywords

**CONNECT**, **GEOM**, **GODIFF**, **GOTURB**, **HYDR**, **MESH**, **PHYSCALE**, **SINGULAR**, **TPERTR**, **TURBULEN**, **DTMASS3D**, **VALBA** FOR **THREED**, **WRIBA** FOR **THREED**, **VALUE** FOR **THREED**

### Syntax

```
elem =      THREED
           junc1      sens1
           junci      sensi
...
           juncn      sensn
WEIGHT    ip          ;

```

<b>elem</b>	: name of the 3d element .
<b>junci sensi</b>	: junction name followed by a keyword which defines the orientation of the junction in the element. This keyword is <b>USTREAM</b> or <b>DSTREAM</b> <sup>1</sup> .
<b>WEIGHT ip</b>	: OPTIONAL keyword followed by a positive integer which defines the weight of the element. The default weight of the element is 1. <b>Definition</b> : The weight of an element is the number of identical elements simulated by this element. The weight of elements is used in mass and energy balances.

<sup>1</sup>The choice is insignificant since you have controlled that for the other element related to this junction, the other keyword is used.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 653/851

228

## TITLE DIRECTIVE

The **TITLE** directive is used in *data block* to give a title to the input deck. Any simulation run with this data block will be initialized with this title (result files FORT21 and FORT07 also).

The maximum number of characters that may be used in this title is 60.

### Associated Keywords

RESULT, PERIOD, LIST, IMPRIME, MESSAGE, PRIN3D

### Syntax

**TITLE**        'xxxx' ;

### Example

**TITLE**        'CANON VERTICAL test 001' ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 654/851

229

## TOURNANT DIRECTIVE

This directive of the *data block* is used to impose a multiplying coefficient on the exchanged heat flux for a range of scalar points which surround a pump element type. This coefficient is either directly given by the operator, either computed by **CATHARE**. When the coefficient is given by the operator, it is also possible to change the value using CCV in the command block.

**Remark :**

1. The pump must be defined before the use of Tournant directive,
2. The range of scalar points must surround the vector point of the pump element.

### Associated Keywords

[COMETE](#)

### Syntax

<b>TOURNANT</b> elem or <b>COMPUTED</b>	<b>SEGMENT</b> <b>IMPOSED</b>	Pi pump	Pj coef ;
	<b>COMPUTED</b>	pump $\alpha$ $\gamma$	$\beta$ R ;

<b>elem</b>	: axial element name
<b>SEGMENT</b>	: keyword indicating that a range of vector points on which the coefficient will be defined, has to be given
<b>Pi</b>	: first vector point belonging to the axial mesh of the element (integer defined by XAXIS or VECTOR operator)
<b>Pj</b>	: second vector point belonging to the axial mesh of the element (integer defined by XAXIS or VECTOR operator)
<b>IMPOSED</b>	: keyword indicating that the value of the constant flux multiplying coefficient has to be given.
or	
<b>COMPUTED</b>	: keyword indicating that the flux multiplying coefficient is computed by the code itself.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 655/851

**pump** : pump name.  
**coef** : real number  $> 0$  representing the coefficient value.  
 **$\alpha, \beta, \gamma, R$**  : real numbers  $> 0$ , entering the correction factor calculation. It is given by the following formula :  

$$\alpha \left[ \beta \frac{\sqrt{\left(\frac{V_L + V_G}{2}\right)^2 + (R\omega)^2}}{\left(\frac{V_L + V_G}{2}\right)} \right]^\gamma$$
with  $V_L$  : liquid velocity  
 $V_G$  : gas velocity  
 $\omega$  : pump rotation speed

### Example

```

PV2 =      VECTOR      FROIDEI    0.2D0 ;
(PV2 is corresponding to the pump vector point)
PV1 =      VECTOR      FROIDEI    0.1D0 ;
PV3 =      VECTOR      FROIDEI    0.3D0 ;

TOURNANT  SEGMENT      PV1        PV3
          IMPOSED     CARPOMI   2.5D0 ;

TOURNANT  SEGMENT      PV1        PV3
          COMPUTED    CARPOMI   0.5D0      0.7D0      1.3D0      .57D0 ;

```

In those two examples, the multiplying coefficient will be imposed on the scalar meshes PS1 = 0.15D0 and PS2 = 0.25D0 located in the range [PV1 , PV3].

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 656/851

230

## TPER3D DIRECTIVE

The **TPER3D** directive is used after **PERMINIT** in the *command block* to limit the virtual physical time to be reached by the **THREED** element during the 3D internal steady state initial guess : by default, the steady state iterates until the virtual time is greater than an estimated convection time *TCONV* ( $\approx$  volume of the threed element / volumetric flowrate through the threed element).

This directive allows to stop the calculation for a virtual time smaller than *TCONV*. Correct 3D flow stabilized state must be controlled by the user through an appropriate stabilized transient.

### Associated Keywords

**THREED, PERMINIT**

### Syntax

**TPER3D**      elem      maxtime ;

<b>elem</b>	: name of the threed element
<b>maxtime</b>	: real number defining the virtual time (s) to be reached by the “steady-state” initial guess.

### Example

PERMINIT	circ1	froide1	froide3	froide4		
	downco3d	froide2	volinf bypass			
	scoeur	couve	plensup	chaude1	geve1	
	interm1	chaude2	geve2	interm2		
	f1	f2	f3	f4	i1	i2 ;
TPER3D	downco3d	1.D3 ;				

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 657/851

231

## TRANFUEL DIRECTIVE

The **TRANFUEL** directive, used in the *command block*, starts a transient time step computation of a stand alone fuel.

The time and the time step are read in the hydraulic data file by either the directive **READHCAT** (fluid file written by Cathare) or the directive **READHEXT** (external fluid file). If a smaller time step *dtmaxi* is imposed by the user (see **OPTION DTMAX**) or by the code, a sub-cycling is performed by the stand alone fuel module in order to reach the time of the hydraulic file in several steps. In this case the hydraulic data are linearly interpolated between  $t_0 = \text{time} - dt$  and  $t = \text{time}$ .

### Associated Keywords

**CATAFUEL**

### Syntax

**TRANFUEL** cata time dt ;

**cata** : name of the catafuel element.  
**time** : real number  $\geq 0$ . Time to be reached at the end of the transient if the time step dt is used.  
**dt** : real number  $> 0$ . representing the time step to be used.

### Example

```

OPTION      DTMAX      dtmaxi ;
REPEAT      BLOC1      nsteps ;
            READHCAT   cata       time       dt ;
            TRANFUEL   cata       time       dt ;
END BLOC1  ;

```

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is TRANFUEL.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 658/851

232

## TRANSENS DIRECTIVE

The **TRANSENS** directive, in the *command block*, starts a transient time step computation for a reactor and activates preliminary calculations for the sensitivity module (Adjoint Sensitivity Method) (direct calculation Jacobian file storage allowing use of SENSIB program).

### Associated Keywords

NEWDT, NEWTIME

### Syntax

**TRANSENS**    circtot                time                dt ;

<b>circtot</b>	: reactor name
<b>time</b>	: real number $\geq 0$ . Time at the end of the transient if the time step dt is used.
<b>dt</b>	: real number $> 0$ . representing the time step to be used.

**N.B.** : The syntax is the same as for the TRANSIENT directive.

For more information about the sensitivity module , see “Manuel utilisateur du module de sensibilité pour l’élément axial de CATHARE” , SMTH/LMDS/EM/200-088.

### Example

```

time =      0. ;
dt =       100. ;
time =      time      +      dt ;
TRANSENS   circ1      time      dt ;
dt =       NEWDT ;
time =     NEWTIME ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 659/851

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is GOTRAS  
CALL GOTRAS (LALIDENH , TIME, TSTEP, \*9999)

LALIDENH	INTEGER, pointer of the head structure of the reactor. Should not be changed.
TIME	DOUBLE PRECISION, expected time
TSTEP	DOUBLE PRECISION, time-step value

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 660/851

233

## TRANSIENT DIRECTIVE

The **TRANSIENT** directive, in the *command block*, starts a transient time step computation for a reactor.

### Associated Keywords

**NEWDT**, **NEWTIME**

### Syntax

**TRANSIENT**    circtot                time                dt ;

<b>circtot</b>	: reactor name
<b>time</b>	: real number $\geq 0$ . Time to be reached at the end of the transient if the time step dt is used.
<b>dt</b>	: real number $> 0$ . representing the time step to be used.

**N.B.** : To reach Newton-Raphson convergence, a smaller time step *dt* can be chosen by **CATHARE**; the operator **NEWTIME** gives the new time reached by the computation step. The operator **NEWDT** gives the recommended *dt* for the next time step.

**Warning** : The only way to force a different value than **NEWTIME** for TIME variable, is to use **RESETIME** directive (reset to zero).

### Example

```

time =      0. ;
dt =      100. ;
REPEAT      BLOCK1      NSTEPS;
time =      time      +      dt ;
TRANSIENT   circ1      time      dt ;
dt =      NEWDT ;
time =      NEWTIME ;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 661/851

**N.B.** : The corresponding FORTRAN subroutine called in PILOT is GOTRAN :  
CALL GOTRAN (LALIDENH , TIME, TSTEP, \*9999)

LALIDENH	INTEGER, pointer of the head structure of the reactor. Should not be changed.
TIME	DOUBLE PRECISION, expected time
TSTEP	DOUBLE PRECISION, time-step value

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 662/851

**234**

## TRIGONOMETRIC FUNCTIONS

### Associated Keywords

MATHEMATIC, EXP, NEQ, AND, MAX, MIN, OR, TRIGONOMETRIC, DEGRE, RADIAN, INTERP, IF, ELSE, ENDIF, LOG

### Syntax

**z =**            **XXXX**            **(x)**            ;

<b>z</b>	: real number output
<b>XXXX</b>	: function name from the list below :
<b>x</b>	: real number input

### 234.1 Sinus

**SINUS**            sine

### 234.2 Cosinus

**COSINUS**            cosine

### 234.3 Tangent

**TANGENT**            tangent

### 234.4 Arcsinus

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 663/851

**ARCSINUS** reciprocal of sine function (check that  $\text{abs}(x) < 1$ ).

## 234.5 Arccosin

**ARCCOSIN** reciprocal of cosine function (check that  $\text{abs}(x) < 1$ ).

## 234.6 Arctangt

**ARCTANGT** reciprocal of tangent function

	<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 664/851</a>

235

## TURBINE OPERATOR

The **TURBINE** operator creates in the *data block* a turbine by defining its characteristics. A turbine will be defined on an **axial** element on a vector point, on an horizontal part of the pipe.

This operator is only designed for steam flow. For any other noncondensable gas, refers to TCOMCHAR operator.

### Associated Keywords

**BWR**, **MODPCST**, **MODPNCST**, **SINK**(purge option), **VALUE FOR TURBINE**, **WRITE FOR TURBINE**

### Syntax

```
TURB1 =      TURBINE    elem
              POINT      ip
              SNOZZLE   snoz
              DELTAP    dtap
              EFFI       eff        or          POWER      pow
              GAMMA     gam           ;

```

<b>elem</b>	: pipe name.
<b>POINT ip</b>	: keyword followed by the vector point value (returned by VECTOR operator) on the axial mesh.
<b>SNOZZLE snoz</b>	: keyword followed by the nozzle section of the turbine ( $m^2$ ).
<b>DELTAP dtap</b>	: keyword followed by a real number $> 0$ , which is the initial head loss through the turbine (Pa), to be as close as possible to the difference of pressure imposed by the other elements after the steady state.
<b>EFFI eff</b>	: keyword followed by a real number $> 0$ , which is the efficiency of the turbine used to compute power from that of an adiabatic turbine.
<b>Or POWER pow</b>	: keyword followed by a real number $> 0$ , which is the power imposed for the turbine (W).
<b>GAMMA gam</b>	: keyword followed by a real number $> 0$ , which is the $\gamma$ coefficient for the gaz ( $\frac{C_p}{C_v}$ ).

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 665/851

<b>Example</b>
----------------

```
STEAMLIN= AXIAL    ...;  
P10=      VECTOR   STEAMLIN  1.5;  
TURB1=    TURBINE  STEAMLIN  
          POINT    P10        SNOZZLE   4.1D-2  
          DELTAP   12.D5     EFFI       0.9  
          GAMMA  1.4    ;
```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 666/851

236

## TURBULEN DIRECTIVE

The **TURBULEN** directive, used in the *data block*, specifies that turbulence will be calculated in the **THREED** module. Turbulence is initialized by means of the (K,ε) model. It can be applied to the liquid phase, the gas phase or both.

The TURBULEN directive also allows the definition of the turbulence initial state via the coefficients **KL0**, **EPSL0** and **KG0**, **EPSC0**.

The turbulence will be activated by the **GOTURB** directive in the *command block*.

### Associated Keywords

**GOTURB, THREED**

### Syntax

```
TURBULEN elem
  TURBLIQ   KL0          kl0           EPSL0        eps10
  TURBGAS   KG0          kg0           EPSC0       eps10
  ;
```

<b>elem</b>	: name of the 3D element.
<b>TURBLIQ</b>	: keyword defining the liquid turbulence model initial state (to be used only if turbulence is to be calculated in the liquid phase). It is followed by:
<b>KL0</b>	: keyword followed by a real number equal to the initial value of k, the liquid turbulent kinetic energy.
<b>EPSL0</b>	: keyword followed by a real number equal to the initial value of ε, the liquid turbulent dissipation rate.
<b>TURBGAS</b>	: keyword defining the gas turbulence model initial state (to be used only if turbulence is to be calculated in the gas phase). It is followed by:
<b>KG0</b>	: keyword followed by a real number equal to the initial value of K, the gas turbulent kinetic energy.
<b>EPSC0</b>	: keyword followed by a real number equal to the initial value of ε, the gas turbulent dissipation rate.

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 667/851

237

## USE DIRECTIVE

The **USE** directive may be used:

1. to assign a time dependant law for gravity to the reactor, or to specify that a gravity value will be given by [CCV](#) to the reactor during the computation.
2. to specify the restart of a CATHARE 2 V2.5\_3 computation with a new *input data deck*.

### Associated Keywords

**SAVE, REACTOR**(directive)

## 237.1 Assign a variable gravity

### Syntax

```
USE      GRAVITY      (GRAVLAW      lawg )      ;
```

**GRAVITY** : keyword to indicate that the computation will be done with a different gravity of the default gravity ( $9.81 \text{ m/s}^2$ )

**GRAVLAW** : optional keyword to indicate that a time dependant law of gravity is to be given. **By default**, the gravity value will be given by CCV in the *command block*.

**lawg** : law entered by the user, corresponding to the gravity variation law as a function of time

### Example

```
LAW      'TIME'      'GRAVITY'  
0.D0      9.81D0  
1.D4      5.D0 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 668/851

**USE            GRAVITY        GRAVLAW        LAW ;**

**USE            GRAVITY        ;**

## 237.2 Specify a restart with a new input data deck

### Syntax

**USE            NEW            DATA  
ndata            RESTART        FILE            nlabel        ;**

**NEW DATA** : keyword indicating that the computation will be done with a new input data deck.  
**ndata** : integer  $> 0$  corresponding to the label which identifies the current input data deck  
**RESTART FILE** : keyword indicating that the computation will be done from a restart file  
**nlabel** : integer  $> 0$  corresponding to the label in a file V25\_3.RESTART from which the computation will be restarted.

### Example

For special applications such as navy power plants safety studies, it is required to modify certain characteristics such as the position of the whole reactor with respect to earth gravity. This can be done during a transient scenario with the directives :

- <USE NEW DATA> (Data Block)
- <RESTORE NEW DATA > (Executable Block)

This methodology allows the user to restore a selected thermalhydraulic state of a plant geometry (V25\_3.RESTART) and apply this state to a different plant geometry (taking into account the pitch of the ship). For this purpose, several *block data* input decks must be built to describe the different plant spatial orientations. It is the user's responsibility to make sure that the topology and the meshing of the circuits are unchanged.

The following steps are required :

1. At the end of a previous calculation, the variables calculated for the initial geometry are saved with a label *nlabel* in a V25\_3.RESTART file:

**SAVE            nlabel ;**

2. In the new block data, the user gives the label *ndata*, and specifies that these new data will be used with the variables saved with the label *nlabel* :

**USE            NEW            DATA  
ndata            RESTART        FILE            nlabel;**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 669/851

3. In the command block of the next calculation, the user must tell that he wants to use the new geometry (with the label *nlabel* on the V25\_3.INIT file) with the variables previously saved with the label *nlabel*. During the allocation phasis, **CATHARE** will check the coherency of the two labels *nlabel* given in the data input deck (in directive USE) and in the restart input deck (in directive RESTORE).

```
RESTORE      NEW          DATA
              ndata        RESTART      FILE           nlabel;
```

*See also* **RESTORE** and **SAVE** directives for more information.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 670/851</a>

238

## UTIL1 TO UTIL20 DIRECTIVES

The **(MPa)UTILx** directive, used in *command block*, enables to incorporate special user Fortran treatments in the calculation scenario.

These directives have a restricted use compared to V1.3. An UTILX in the *command block* is translated into a ‘CALL UTILX’ in the FORTRAN subroutine PILOT, without any possibility to put arguments.

In order to get easy access to the plant physical variables, it is strongly recommended for UTILx subroutines to rely on standard user interfaces such as **CCV** (VALUE, WRITE directives). For useful directives, the corresponding Fortran calling protocol is available in this document.

### Associated Keywords

**SENSOR, VALUEFLD, VALBA, WRIBA, VALUFEAU**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 671/851

239

## VALBA OPERATOR

The **VALBA** operator is the specific operator for radio-chemical components used to provide direct access to certain variables as **VALUE** operator is doing for all other variables. It must be used in the *command block*, with predefined names called “Cathare Computation Variable” (**CCV**) described as follows.

**Warning :** The name of the variable receiving the value of the CCV must begin by I, J, K, L or M when the value is of INTEGER type.

### Associated Keywords

**VALUE, WRITE, SENSOR, VALUEFLD, (MPa)UTILx, WRIBA,, VALUFEAU**

**NB :** The corresponding FORTRAN function invoked in PILOT is VALBA. Arguments are the following: X= VALBA ( KEYWOR, OBJNAM, IMESH, IRAD, BANAME, IVSTAT)

KEYWOR	CHARACTER*8 name of the variable to be read
OBJNAM	CHARACTER*8 name of the element
IMESH	INTEGER mesh number
	<ul style="list-style-type: none"> <li>• 0 if no mesh number,</li> <li>• 1 for lower sub-volume ,</li> <li>• 2 for upper sub-volume</li> </ul>
IRAD	INTEGER 0, not used.
BANAME	CHARACTER*8 name of the radio-chemical component
IVSTAT	INTEGER error code

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 672/851

## 239.1 CCVs calculated in a CIRCUIT

### Syntax

<b>x =</b>	<b>VALBA</b>	<b>GLOBAL_NAMEVAR</b>	<b>elem1</b>	<b>obj</b>	<b>;</b>
	<b>or</b>	<b>NAMEVAR</b>	<b>circuit1</b>	<b>obj</b>	<b>compo;</b>

**GLOBAL\_NAMEVAR:** name of an overall variable of the circuit.

**NAMEVAR** : name of a variable attached to a radio chemical component.

**Circuit1** : circuit name.

**Obj** : integer equal to 0 in that case (circuit).

**Compo** : OPTIONAL variable (only used with NAMEVAR) giving the name of the radio-chemical component for which the value is read (the list of pre-defined components is given in the description of the RADCHEMI operator) .

### Names of the variables which can be read :

<b>GLOBAL_NAMEVAR</b>	
FLAG_IEA	integer to indicate the Emergency Shutdown state : ON=1 – OFF=0 <sup>1</sup>

<b>NAMEVAR</b>	<b>DESCRIPTION</b>
HFLIFE	real representing the half-life period (s)
IRA_NB	integer to indicate the component type (see RADCHEMI operator) : <sup>1</sup> =0 : non gaseous, non radioactive component =1 : non gaseous, radioactive component =2 : gaseous, radioactive component =3 : gaseous, non radioactive component
IRG_NB	integer to indicate the emissivity peak : ON=1 – OFF=0 <sup>1</sup>
IDP_NB	integer to indicate if the peak duration is used (=1) or not (=0) (fission products only ; see RADCHEMI operator) <sup>1</sup> =0 : “ratio” is the primary mean specific activity amplification factor =1 : “ratio” is the peak duration
KA_CST	Ka constant <sup>2</sup>
HENRY_	Henry constant <sup>2</sup>
EVAPOR	entrainment coefficient due to vaporization
CONDEN	entrainment coefficient due to condensation
DISSOL	dissolution time constant
DEGASA	time constant associated to the gas stripping
RELACH	for fission products (IMR = 0) : release rate (in GBq/s) before Emergency Shutdown for radiolysis or activation products (IMR = 1) : proportionality factor between the activity release rate and the neutron flux <sup>1</sup>
AMPLIF	amplifying factor of the rate of emission <sup>1</sup> only for fission products (IMR=0) not used for IMR=1

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 673/851

RATIO_	activity ratio or peak duration (see above IDP_NB) <sup>1</sup>
NEUPOW	Neutron power increase at emergency shutdown <sup>1</sup>
RCVEFF	efficiency of the Chemical and Volume Control filters <sup>2</sup>
MASMOL	molar mass value <sup>2</sup>
IMR_NB	integer to indicate if the relach rate is used (=0) or not (=1) <sup>2</sup> (see RADCHEMI operator) =0 : “relach” constant is assigned to the release rate (in GBq/s) =1 : “relach” constant is assigned to the proportionality factor between the activity release rate and the neutron flux
XBAMOY	mean concentration in the circuit

### Example

```

primcir =      CIRCUIT ...
xeffbo =      VALBA      RCVEFF      primcir      0          IODE131 ;
istop =        VALBA      FLAG_IEA     primcir      0 ;

```

<sup>1</sup>must be read in the circuit including the fuel wall

<sup>2</sup>this constant has the same value in each circuit

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 674/851

## 239.2 CCVs calculated in an ELEMENT

### Syntax

**x =**           **VALBA**           **GLOBAL\_NAMEVAR**           **elem1**           **obj**           **;**  
               **or**           **NAMEVAR**           **elem1**           **obj**           **compo** ;

**GLOBAL\_NAMEVAR:** name of an overall variable (none component **compo** should be used).

**NAMEVAR**           : name of a variable attached to a component.

**Elem1**           : element name

**obj**           : argument defined in the table below (mesh number , SUP or INF ...)

obj	description
f	fuel number
s	scalar point
m	upper sub-volume : keyword SUPlower sub-volume : keyword INF
0	global variable
no	not available

**compo**           : optional variable, only used with NAMEVAR, giving the name of the radio-chemical component for which the value is read.

### Names of the variables which can be read :

	Description	value of obj				
		1-D	0-D	3-D	BC	RG
<b>GLOBAL_NAMEVAR</b>						
FLAG_IEA	integer to indicate the Emergency Shutdown state : ON=1 – OFF=0	0	0	0	0	0

NAMEVAR					
HFLIFE	real representing the half-life period (s) <sup>2</sup>	0	0	0	0
IRA_NB	integer to indicate the component type <sup>2</sup> =0 : non gaseous, non radioactive component =1 : non gaseous, radioactive component =2 : gaseous, radioactive component =3 : gaseous, non radioactive component	0	0	0	0

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A				
	<b>Document technique DEN</b>	Page 675/851				

IRG_NB	integer to indicate the emissive peak : ON=1 – OFF=0 <sup>1</sup>	0	0	0	0	0
KA_CST	Ka constant <sup>2</sup>	0	0	0	0	0
HENRY_	Henry constant <sup>2</sup>	0	0	0	0	0
EVAPOR	entrainment coefficient due to vaporisation	s	m	s	no	no
CONDEN	entrainment coefficient due to condensation	s	m	s	no	no
DISSOL	dissolution time constant	s	m	s	no	no
DEGASA	time constant associated to the gas stripping	s	m	s	no	no
MASMOL	molar mass value <sup>2</sup>	0	0	0	0	0
IMR_NB	integer to indicate if the release rate is used (=0) or not (=1) (see RADCHEMI operator) =0 : “relach” constant is assigned to the release rate (in GBq/s) =1 : “relach” constant is assigned to the proportionality factor between the activity release rate and the neutron flux	0	0	0	0	0
RELACH	for fission products (IMR = 0) : release rate (in GBq/s) before Emergency Shutdown for radiolysis or activation products (IMR = 1) : proportionality factor between the activity release rate and the neutron flux <sup>1</sup>	0	0	0	0	0
AMPLIF	amplifying factor of the rate of emission <sup>1</sup> only for fission products (IMR=0) not used for IMR=1	0	0	0	0	0
IDP_NB	integer to indicate if the peak duration is used (=1) or not (=0) =0 : “ratio” is the primary mean specific activity amplification factor =1 : “ratio” is the peak duration (fission products only ; see RADCHEMI operator) <sup>1</sup>	0	0	0	0	0
RATIO_	activity ratio or peak duration (see above IDP_NB) <sup>1</sup>	0	0	0	0	0
NEUPOW	Neutron increase power at emergency shutdown <sup>1</sup>	0	0	0	0	0
RCVEFF	efficiency of the Chemical and Volume Control filters	0	0	0	0	0
ACMULT	Multiplicative coefficient relative to neutron flux (equal to 0 if the production of the radio chemical component does not depend on this flux, else equal to 1) <sup>1</sup>	0	no	0	no	no
CORUPT	Curvilinear abscissas (m) where the cladding rupture is defined <sup>1</sup>	0	no	f	no	no
PCRUPT	Percentage of ruptured rods <sup>1</sup>	0	no	f	no	no
DTRUPT	Period of time during which the rupture occurs (s) <sup>1</sup>	0	no	f	no	no
LIQFRA	specific concentration (chemical component) or specific activity (radioactive component) in the liquid phase	s	m	s	0	0

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 676/851

GASFRA	specific concentration (chemical component) or specific activity (radioactive component) in the gas phase	s	m	s	0	0
XSOLID	mass of crystallized component	s	m	s	no	no
MASACT	mass/activity balance by component	0	0	0	0	0
XBAMOY	average concentration	0	no	no	no	no

### Example

```

valr=      VALBA      RELACH      elemr      0          HPLUS ;
irate=     VALBA      RATIO_      elemr      0          XENON133 ;
isca=      SCALAR     elemr      3.8 ;
liqc=      VALBA      LIQFRA     elemr      isca       BORON ;

vol1=      VOLUME ...
xcav=      VALBA      GASFRA    vol1       INF        KRYPTO88;

```

<sup>1</sup>must be read in the element including the fuel wall

<sup>2</sup>this constant has the same value in element of each circuit

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 677/851

## 239.3 CCVs calculated at a JUNCTION

### Syntax

```
x =      VALBA      NAMEVAR    junct1      obj      compo ;
```

<b>NAMEVAR</b>	: name of a variable attached to a component.
<b>junct1</b>	: junction name.
<b>obj</b>	: integer equal to 0 in that case.
<b>compo</b>	: word giving the name of the radio-chemical component for which the value is read (the list of pre-defined components is given in the description of the RADCHEMI operator).

### Names of the variables which can be read :

ULIQFR	upstream activity or concentration (GBq/kg or kg of chemical components / kg of liquid) in liquid phase
UGASFR	upstream activity or concentration (GBq/kg or kg of chemical components / kg of gas ) in gas phase
DLIQFR	downstream activity or concentration (GBq/kg or kg of chemical components / kg of liquid) in liquid phase
DGASFR	downstream activity or concentration (GBq/kg or kg of chemical components / kg of gas) in gas phase

Refer to **VALUE** directive for a junction for further explanation of upstream and dstream notions for a junction.

### Example

```
juliqfr =      VALBA      ULIQFR    junct      0      IODE131 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 678/851

## 239.4 CCVs calculated in a ZONE

### Syntax

```
x =      VALBA      NAMEVAR    zone1      obj      compo ;
```

<b>NAMEVAR</b>	: name of a variable attached to a component.
<b>zone1</b>	: zone name.
<b>obj</b>	: integer equal to 0 in that case (zone).
<b>compo</b>	: word giving the name of the radio-chemical component for which the value is read (the list of pre-defined components is given in the description of the RADCHEMI operator).

### Names of the variables which can be read :

XBAMOY	mean concentration in the zone (GBq/kg or kg of chemical components / kg of fluid)
MASACT	mass/activity balance by component (GBq or kg)

### Example

```
z bamoy =      VALBA      XBAMOY    zone1      0      IODE131 ;
z masact =      VALBA      MASACT    zone1      0      BORON ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 679/851

## 239.5 CCVs calculated in a ZONE 3D

### Syntax

x =                   **VALBA**                   **NAMEVAR**                   zone1                   obj                   compo ;

<b>NAMEVAR</b>	: name of a variable attached to a component.
<b>zone1</b>	: zone name.
<b>obj</b>	: integer equal to 0 in that case (zone).
<b>compo</b>	: word giving the name of the radio-chemical component for which the value is read (the list of pre-defined components is given in the description of the RADCHEMI operator).

### Names of the variables which can be read :

<b>XBAMOY</b>	average concentration in the zone (GBq/kg or kg of chemical components / kg of fluid)
<b>MASACT</b>	mass/activity balance by component (GBq or kg)
<b>MASDEP</b>	Total crystallized mass (kg)

### Example

z bamoy =           **VALBA**                   **XBAMOY**                   zone1                   0                   IODE131 ;  
 z masact =           **VALBA**                   **MASACT**                   zone1                   0                   BORON ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 680/851

## 239.6 CCVs calculated in a PIQxxx gadget

### Syntax

**x = VALBA NAMEVAR elem1 obj compo;**

<b>NAMEVAR</b> <b>elem1</b> <b>obj</b> <b>compo</b>	: name of a variable attached to a component. : piqxxx gadget name. : argument equal to 0 in that case. : variable giving the name of the radio-chemical component for which the value is read. (The list of pre-defined components is given in the description of the RADCHEMI operator).
--	--

### Names of the variables which can be read :

XLFLOW	flow of the component in liquid phase (GBq/s or kg/s).
XGFLOW	flow of the component in liquid phase (GBq/s or kg/s)
GASFRA	activity or concentration (GBq/kg or kg of chemical components / kg of gas ) in gas phase inside the element
LIQFRA	activity or concentration (GBq/kg or kg of chemical components / kg of liquid) in liquid phase inside the element.
GASFRX	activity or concentration (GBq/kg or kg of chemical components / kg of gas) in gas phase outside the element
LIQFRX	activity or concentration (GBq/kg or kg of chemical components / kg of liquid) in liquid phase outside the element
QTFLW	total flow (GBq/s or kg/s)
MASACT	cumulated value for QTFLW (GBq or kg)

### Example

qdeclbo = VALBA XLFLOW decharsi 0 BORON ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 681/851

## 239.7 CCVs in a SOURCE, a SINK or a BREAK

### Syntax

**x = VALBA NAMEVAR elem1 obj compo ;**

<b>NAMEVAR</b>	: name of a variable attached to a component.
<b>Elem1</b>	: sink name or source name.
<b>obj</b>	: argument equal to 0 in that case.
<b>compo</b>	: variable giving the name of the radio-chemical component for which the value is read. (The list of pre-defined components is given in the description of the RADCHEMI operator).

### Names of the variables which can be read :

LIQFRA	activity or concentration (GBq/kg or kg of chemical components / kg of liquid water) in liquid phase
GASFRA	activity or concentration (GBq/kg or kg of chemical components / kg of gas) in gas phase
XLFLOW	activity or concentration flow of component in liquid phase (GBq/s or kg/s)
XGFLOW	activity or concentration flow of component in gas phase (GBq/s or kg/s)

### Example

**qdeclbo = VALBA XLFLOW decharsi 0 BORON ;**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 682/851

## 239.8 CCVs calculated in a SGTR

### Syntax

**x = VALBA NAMEVAR elem1 obj compo;**

**NAMEVAR** : name of a variable attached to a component.  
**Elem1** : sgtr name  
**obj** : 
 

- 1 for sgtr of type “GVFUIT” or “BETHSY” (in this case, partial variable and global variable is the same )
- 1 or 2 for sgtr of type “GVGUIL”
  - 1: part of sgtr coming from hot side
  - 2: part of sgtr coming from cold side.

  
**compo** : variable giving the name of the radio-chemical component for which the value is read. (The list of predefined components is given in the description of the RADCHEMI operator).

### Names of the variables which can be read :

LIQFRA	activity or concentration (GBq/kg or kg of chemical components / kg of liquid) in liquid phase, on hot or cold side
GASFRA	activity or concentration (GBq/kg or kg of chemical components / kg of gas) in gas phase, on hot or cold side
QTFLOW	total flow (GBq/s or kg/s) , on hot or cold side
XLFLOW	flow of the component in liquid phase (GBq/s or kg/s), on hot or cold side
XGFLOW	flow of the component in gas phase (GBq/s or kg/s), on hot or cold side
MASACT	cumulated value for QTFLOW (GBq or kg)

### Example

**qdeclbo = VALBA XLFLOW decharsi 0 BORON ;**

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 683/851

240

## VALUEFLD DIRECTIVE

The **VALUEFLD** directive provides a direct access from the *command block* to the **fluid thermodynamic and transport properties** of the main fluid of a circuit. The user provides as input the gas/liquid state variables; then the corresponding properties (no derivatives) can be on the basis of predefined symbols, using the reserved OZ prefix. The available properties and their associated symbols are described hereafter.

### Associated Keywords

**VALUE, VALUFEAU**

### Syntax

```

VALUEFLD cirname
  PRESSURE valp
  LIQH valhl
  or      GASH valhg
  or      LIQTEMP valtl
  or      GASTEMP valtg
  (X1FRACT valx1
   ...
   X4FRACT valx4);

```

<b>cirname</b>	: name of the circuit in which the gas/liquid functions will be calculated. <b>Warning</b> : the user should be aware that this information is required to provide correct non condensable gas definition.
<b>PRESSURE</b> <b>valp</b>	: keyword followed by the value valp of the pressure (Pa)
<b>LIQH</b> <b>valhl</b>	: keyword followed by the value valhl (J/kg) of the liquid enthalpy
<b>GASH</b> <b>valhg</b>	: keyword followed by the value valhg (J/kg) of the gas enthalpy
<b>LIQTEMP</b> <b>valtl</b>	: keyword followed by the value valtl (°C) of the liquid temperature
<b>GASTEMP</b> <b>valtg</b>	: keyword followed by the value valtg (°C) of the gas temperature
<b>(XiFRACT</b> <b>valxi</b> )	: OPTIONAL keyword(s) followed by the value(s) valxi (mass concentration) of the $i^{th}$ noncondensable fraction, $i = 1 \text{ to } 4$ . XiFRACT data specification must match (number and correct order) the circuit noncondensable gases specifications ; these data are mandatory when dealing with the gas phase or the liquid phase as well, but they are actually used only for gas phase thermodynamic and transport properties.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 684/851</a>

**The names of properties which can be obtained are given in the following table :**

SYMBOL	definition
OZHqliq	enthalpy of liquid (J/kg)
Oztliq	temperature of liquid (°C)
Ozroliq	density of liquid (kg/m <sup>3</sup> )
Ozcpliq	specific heat of liquid (J/kg/°C)
Ozconliq	conductivity of liquid (W/m/K)
Oztmuliq	viscosity of liquid (kg/m.s)
Ozcpgas	specific heat of gas (J/kg/°C)
Ozcongas	conductivity of gas (W/m/K)
Oztmugas	viscosity of gas (kg/m.s)
Ozhgas	enthalpy of gas (J/kg)
Oztgas	temperature of gas (°C)
Ozrogas	density of gas (kg/m <sup>3</sup> )
Ozsatp	saturation temperature at total pressure (°C)
Ozhlsap	saturation enthalpy of liquid at total pressure (J/kg)
Ozhvsap	saturation enthalpy of gas at total pressure (J/kg)
Ozsatpv	saturation temperature at partial steam pressure (°C)
Ozhlsapv	saturation enthalpy of liquid at partial steam pressure (J/kg)
Ozhvsapv	saturation enthalpy of gas at partial steam pressure (J/kg)
Ozsigmal	surface tension (N/m)
Ozpv	partial pressure of steam (Pa)
Ozhv	partial enthalpy of steam (J/kg)
Ozrovap	partial density of steam (kg/m <sup>3</sup> )
Ozhxi	(i=1,NINCON) enthalpy of the i-th non condensable gas (J/kg) NINCON = number of non condensable gases in the circuit

### Example

CIRPRI and CIRSEC are two circuits

There are two noncondensable gases in CIRPRI and none in CIRSEC

```
VALUEFLD CIRPRI
  PRESSURE    150.D5
  GASH        2.3D6
  X1FRACT    1.D-7
  X2FRACT    1.D-7 ;
```

XX = OZROGAS ;

MESSAGE ' GAS DENSITY ', OZROGAS ;

```
VALUEFLD CIRPRI
  PRESSURE    150.D5
  LIQH        1.24D6
  X1FRACT    0.D0
  X2FRACT    0.D0 ;
```

MESSAGE ' LIQUID TEMPERATURE ', OZTLIQ ;

VALUEFLD CIRSEC

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 685/851

PRESSURE      60.D5

LIQTEMP

220.D0 ;

MESSAGE 'SATURATION TEMPERATURE',                    OZTSATP ;  
 MESSAGE 'SATURATION ENTHALPY OF LIQUID',        OZHLSAP ;

**NB :** The corresponding FORTRAN file called in PILOT is the VALUEFLD subroutine:

```
CALL VALUEFLD ( ITYPENT ,NINC ,VALP ,VALTHLG ,VALX1 ,VALX2 ,VALX3 ,VALX4
                ,CIRNAM ,IERROR
                ,OZHЛИQ ,OZTЛИQ ,OZROLIQ ,OZCPLIQ
                ,OZCONLIQ,OZTMULIQ,OZHГAS ,OZTGAS
                ,OZROGAS ,OZCPGAS ,OZCONGAS,OZTMUGAS
                ,OZTSATP ,OZHLSAP ,OZHVSAP ,OZTSATPV
                , OZHLSAPV ,OZHVSAPV ,OZSIGMAL ,OZPV
                , OZHV ,OZROVAP ,OZHХ1 ,OZHХ2 ,OZHХ3
                , OZHХ4 ,*9999)
```

ITYPENT	Integer giving the type of request (1 : liquid enthalpy ; 2 : liquid temperature; 3 : gas enthalpy ; 4 : gas temperature)
NINC	Number of non condensables gases in the circuit (integer)
VALP	Given value of pressure (real number)
VALTHLG	Given value of liquid or gas enthalpy or temperature (real number)
VALXi	Given value of I-th non condensible gas mass fraction (real number)
CIRNAM	Name of the circuit (character*8)
IERROR	Integer for error treatment
OZ***	Returned values (see symbol table above) (real numbers)

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 686/851

241

## VALUE OPERATOR

The **VALUE** operator provides a direct access to certain variables, in the *command block*, with predefined names called “Cathare Computation Variables” ([CCV](#)).

### Associated Keywords

**VALBA, WRITE, SENSOR, VALUEFLD, (MPa)UTILx, WRIBA, VALUFEAU**

The value -9999999 is returned when the variable has not been calculated (for example, before GOPERM)

**NB :** The corresponding FORTRAN functions called in PILOT are :

- VALUE for DOUBLE PRECISION type variables: ZVAL = VALUE ( KEYWOR, CNAME, IMESH, IRAD, IVSTAT)
- IVALUE for INTEGER type variables: IVAL = IVALUE ( KEYWOR, CNAME, IMESH, IRAD, IVSTAT)
- CVALUE for CHARACTER\*8 type variables: CVAL = CVALUE ( KEYWOR, CNAME, IMESH, IRAD, IVSTAT)

KEYWOR CNAME IMESH IRAD IVSTAT	CHARACTER*8 name of the variable to be read CHARACTER*8 name of the element INTEGER mesh number – 0 if no mesh number, 1 for lower sub-volume , 2 for upper sub-volume INTEGER = the radial mesh number for walls, or radio-chemical number for hydraulic components =0 in the other case Returned error code (INTEGER) (0 if none , -1 if fatal error)
--	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 687/851

## 241.1 CCVs for the USER common

### Syntax

- Activation of XUSER, KUSER, CUSER arrays :

```
WRITE      XUSER      ci1          cp1 ;
WRITE      KUSER      ci2          cp2 ;
WRITE      CUSER      ci3          cp3 ;
```

- Filling of the USER common:

```
xval =      VALUE      XUSER      i1 ;
kval =      VALUE      KUSER      i2 ;
cval =      VALUE      CUSER      i3 ;
```

<b>xval</b>	: real number obtained
<b>kval</b>	: integer number obtained
<b>cval</b>	: character*8 obtained
<b>XUSER</b>	: name of the array (keyword)
<b>KUSER</b>	: name of the array (keyword)
<b>CUSER</b>	: name of the array (keyword)
<b>i1</b>	: index in the array XUSER $0 < i1 < 750$
<b>i2</b>	: index in the array KUSER $0 < i2 < 250$
<b>i3</b>	: index in the array CUSER $0 < i3 < 250$
<b>ci1</b>	: lower index in the array XUSER (ci1 should not be lower than 1)
<b>cp1</b>	: higher index in the array XUSER (cp1 should not be higher than 750)
<b>ci2</b>	: lower index in the array KUSER (ci2 should not be lower than 1)
<b>cp2</b>	: higher index in the array KUSER (cp2 should not be higher than 250)
<b>ci3</b>	: lower index in the array CUSER (ci3 should not be lower than 1)
<b>cp3</b>	: higher index in the array CUSER (cp3 should not be higher than 250)

**NB** : The variables in the arrays XUSER, KUSER, and CUSER are saved with the storage frequency of the REACTOR.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 688/851

## 241.2 CCVs calculated in a REACTOR

### Syntax

ival =            VALUE            NAMEVAR       reactor;

NAMEVAR : name of the variable  
 reactor : reactor name

#### Names of the variables which can be read :

##### 241.2.1 General variables

NBPROCS	: number of processors used
MAXREP	: maximum number of restart allowed for each time step
DTMINCY	: minimum time step value reached in a cycle (see cycle management for reactor : MANAGE directive)

##### 241.2.2 Variables for simulator use

CPUPPG	: CPU time to fill the educational buffer common (PPDG for SIPA simulator)
CPUSAV	: CPU time to fill the initialization vector common

##### 241.2.3 Variables for user file use

READSTAT	: flag (set to 1) used to indicate that the end of the user file is reached.
----------	--

##### 241.2.4 Variables for COMETE application:

GRAVEXT	: external value of the gravity in m/s2
ITYPGRAV	: type of gravity ITYPGRAV = 1 gravity imposed by VCC ITYPGRAV = 2 gravity imposed by an internal law (see MODGRAV directive)

### Example

NPROC =            VALUE            NBPROCS       CIRCTOT;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 689/851

## 241.3 CCVs calculated in a CIRCUIT

### Syntax

**x =                    VALUE                    NAMEVAR                    circuit1;**

**NAMEVAR**                    : name of the variable  
**circuit1**                    : circuit name

#### Names of the variables which can be read :

<b>TOTMASS</b>	: total mass of the circuit (kg)
<b>LIQMASS</b>	: liquid mass of the circuit (kg)
<b>MASERROR</b>	: mass error (kg)
<b>FLUIDNRJ</b>	: total fluid energy in the circuit (J/kg)
<b>NRJERROR</b>	: energy error (J/kg) NRJERROR is not available if a 3D element is defined within the circuit, its value is set to INF
<b>XjTOTMAS</b>	: total mass of non-condensable gas j in the circuit (kg)
<b>XjMASERR</b>	: mass error for non-condensable gas j in the circuit (kg)
<b>CWALLNRJ</b>	: cumulated total increase of wall internal energy in the circuit (J)
<b>CWENERR</b>	: cumulated energy error (J)
<b>ICUCIR</b>	: number of cumulated iterations
<b>NINCON</b>	: number of non condensable gas in the circuit

For the complete radio-chemical information, refer to **VALBA** operator

### Example

**cmass =                    VALUE                    TOTMASS                    circuit1 ;**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 690/851

## 241.4 CCVs calculated in an ELEMENT

**Characteristics of OBJ1 :**

J	junction number : order as defined in the input deck
M	upper sub-volume ⇒ keyword SUP lower sub-volume ⇒ keyword INF
R	nothing
S	scalar point
Si	internal scalar point
V	vector point
VX	3D X vector point
VY	3D Y vector point
VZ	3D Z vector point
N	N = Max (VX,VY,VZ)
	not available
T	Tee number : order as defined in input deck relating to the carrying AXIAL element

### Syntax

**x =                    VALUE                    NAMEVAR                    elem obj1;**

**NAMEVAR**                    : name of the variable  
**elem**                        : element name  
**obj1**                        : argument defined in the table below (mesh number, SUP or INF, junction number for vector variable at volume ports)

**NB :** For radio-chemical information, refer to **VALBA** operator

The names of variables which can be read and the value of obj1 for each type of element are given in the following tables :

### 241.4.1 General variables

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
PRESSURE	S	M or S	S	R	pressure (Pa)
LIQH	S	M or S	S	R	enthalpy of liquid (J/kg)
GASH	S	M or S	S	R	enthalpy of gas (steam + non condensable) (J/kg)

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 691/851

XiFRAC <i>T</i>	S	M or S	S	R	mass fraction of non condensable number i
ALFA	S	M or S	S	R	void fraction
LIQTEMP	S	M or S	S	R	temperature of liquid (°C)
GASTEMP	S	M or S	S	R	temperature of gas (°C)
SATTEMP	S	M or S	S	R	saturation temperature (°C)
TSATPV	S	M or S	S	R	saturation temperature at vapor pressure (°C)
LIQDENS	S	M or S	S	R	density of liquid (kg/m <sup>3</sup> )
GASDENS	S	M or S	S	R	density of gas (kg/m <sup>3</sup> )
AVGDENS	S	M or S	S	R	average density (kg/m <sup>3</sup> )
IQL	S	M or S			QLE index (liquid-interface heat transfer)
IQG	S	M or S			QVE index (steam-interface heat transfer)
ITOVI	V	J		R	zone index for interfacial friction
LIQV	V	J		R	velocity of liquid (m/s)
SIGMA	S		S		vapor surface tension (N/m)
MUVAP	S		S		vapor dynamic viscosity (kg/m.s)
MULIQ	S		S		liquid dynamic viscosity (kg/m.s)
LIQVX			VX		X component of liquid velocity (m/s)
LIQVY			VY		Y component of liquid velocity (m/s)
LIQVZ			VZ		Z component of liquid velocity (m/s)
GASV	V	J		R	velocity of gas (m/s)
GASVX			VX		X component of gas velocity (m/s)
GASVY			VY		Y component of gas velocity (m/s)
GASVZ			VZ		Z component of gas velocity (m/s)
LIQFLOW	V	J	J	R	liquid flow rate (kg/s)
LIQFLOWX			VX		X component of liquid flowrate (kg/s)
LIQFLOWY			VY		Y component of liquid flowrate (kg/s)
LIQFLOWZ			VZ		Z component of liquid flowrate (kg/s)
GASFLOW	V	J	J	R	gas flow rate (kg/s)
GASFLOWX			VX		X component of gas flowrate (kg/s)
GASFLOWY			VY		Y component of gas flowrate (kg/s)
GASFLOWZ			VZ		Z component of gas flowrate (kg/s)
STMFLOW					steam flow rate (kg/s)
TOTFLOW	V	J	J	R	total flow rate (kg/s)
XiFLOW	V	J	J	R	i <sup>th</sup> non condensable gas flowrate (kg/s)
COEFROT1	V	J		R	singularity head loss coefficient (positive with respect to the meshing flow direction), if constant
COEFROL1	V	J		R	singularity head loss coefficient (positive with respect to the meshing flow direction) for liquid phase, if Reynolds dependant or constant
COEFROG1	V	J		R	singularity head loss coefficient (positive with respect to meshing the flow direction) for gas phase, if Reynolds dependant or constant
XFR1X			VX		singularity head loss coefficient in X positive direction
XFR1Y			VY		singularity head loss coefficient in Y positive direction
XFR1Z			VZ		singularity head loss coefficient in Z positive direction
COEFROT2	V	J		R	singularity head loss coefficient (negative with respect to the meshing flow direction), if constant

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 692/851

COEFROL2	V	J		R	singularity head loss coefficient (negative with respect to the meshing flow direction) for liquid phase, if Reynolds dependant or constant
COEFROG2	V	J		R	singularity head loss coefficient (negative with respect to the meshing flow direction) for gas phase, if Reynolds dependant or constant
XFR2X			VX		singularity head loss coefficient in X negative direction
XFR2Y			VY		singularity head loss coefficient in Y negative direction
XFR2Z			VZ		singularity head loss coefficient in Z negative direction
RADSTAT	R		R		radiative exchange activation flag (value is 0 or 1)
LIQMASS	R	R	R		total liquid mass of an element (kg)
STEAMASS	R	R	R		total steam mass of an element (kg)
GASMASS	R	R	R		total gas mass of an element (kg)
XiMASS	R	R	R		mass of noncondensable number i (kg)
FLUIDNRJ	R	R	R		energy of fluid (J)
MASERROR	R	R	R		error of mass balance (instantaneous) (kg)
NRJERROR	R	R			error of energy balance (instantaneous) (J)
TOTPOWER	R	R			total power exchanged by walls in the element on wet side (W)
PXNEUT	R				Fraction of kinetics power dissipated in the fluid
TOTPWT	R	R	R		exchanged power between wall and fluid (W)
TOTLOSS	R	R	R		total energy exchanged by walls in the element on dry side (TOTLOSS $\geq 0$ if the power is lost by the wall, and $\leq 0$ if the power is received by the wall) (W)

#### 241.4.2 Additional variables for AXIAL element

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
LIQMASSM	Si				liquid mass in an internal mesh (kg)
GASMASSM	Si				gas mass in a internal mesh (kg)
TXENT	V			R	entrainment rate
TXSTRAT	V			R	stratification rate
TECOND	T				flag for special condensation correlation in tee
ITDIVER	T				TEE JETPUMP momentum activation flag = 3608 if enabled = 0 if disabled
ROMOY	R				average density of the coolant ( $\text{kg}/\text{m}^3$ ) : Case of a BY-PASS sub type element
COLAPLVL	R				elevation of the collapsed level of the element (m) with respect to the first vector mesh of this element Warning: it may be $< 0$ :
HUWSCHEM	V				Activation of the flag for the 2 <sup>nd</sup> order donor-cell scheme for CGR.
HCOEFPO	S				multiplicative coefficient of the flux ( $\text{W}/\text{m}^2$ ) in case of a pump used for comete application.

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 693/851

#### 241.4.3 Variables for coupling with external codes: momentum and energy sources

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
DPGEXT	V				Pure momentum source for the gas phase (Pa)
DPLEXT	V				Pure momentum source for the liquid phase (Pa)
OVPGEXT	V				Indicator (double) giving the advective term in the gas momentum equation. < -1.: advective term = 0 for negative gas velocity > 1.: advective term = 0 for positive gas velocity else : standard CATHARE advective term
OVPLEXT	V				Indicator (double) giving the advective term in the liquid momentum equation. < -1.: advective term = 0 for negative liquid velocity > 1.: advective term = 0 for positive liquid velocity else : standard CATHARE advective term
OVHGEXT	S				Indicator (double) giving the enthalpy considered in the convective term of the gas energy equation. < -1.: upstream enthalpy = ENTHEEXT (see below) for negative gas velocity > 1.: upstream enthalpy = ENTHEEXT (see below) for positive gas velocity else : standard CATHARE convective term
OVHLEXT	S				Indicator (double) giving the enthalpy considered in the convective term of the liquid energy equation. < -1.: upstream enthalpy = ENTHEEXT (see below) for negative liquid velocity > 1.: upstream enthalpy = ENTHEEXT (see below) for positive liquid velocity else : standard CATHARE convective term
ENTHEXT	S				Enthalpy considered in the convective term of the gas (resp. liquid) energy equation when OVHGEXT (resp. OVHLEXT) is < -1. or > 1. (J/kg)

#### 241.4.4 Variables for sensitivity calculations

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1TOI	V	J		R	Toi sensitivity parameter
SP1TOX			VX		Toi sensitivity parameter along X-axis
SP1TOY			VY		Toi sensitivity parameter along Y-axis
SP1TOZ			VZ		Toi sensitivity parameter along Z-axis
SP1QLE	Si	M	Si		Qle sensitivity parameter
SP1DGQVE	Si	M	Si		Droplet diameter sensitivity parameter for QVE
SP1QVE	Si	M	Si		Qve sensitivity parameter
SP1CL	V	J		R	wall to liquid friction sensitivity parameter when there is no reflooding
SP1CLR	V				wall to liquid friction sensitivity parameter in case of reflooding

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>					DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A
					Document technique DEN
					Page 694/851

SP1CLV		J			wall to liquid friction sensitivity parameter
SP1CG	V	J		R	wall to steam friction sensitivity parameter
P1CLX			VX		wall to liquid friction sensitivity parameter along X
P1CLY			VY		wall to liquid friction sensitivity parameter along Y
P1CLZ			VZ		wall to liquid friction sensitivity parameter along Z
P1CGX			VX		wall to steam friction sensitivity parameter along X
P1CGY			VY		wall to steam friction sensitivity parameter along Y
P1CGZ			VZ		wall to steam friction sensitivity parameter along Z
P1QLF	Si	M	Si		QLE flashing sensitivity parameter
SP3QLF	Si	M	Si		QLE flashing delay sensitivity parameter
PQGT	Si	M	Si		Droplet flow sensitivity parameter for QLE
P1TOA	V	J		R	Toi sensitivity parameter for annular flow
P1TOB	V	J		R	Toi sensitivity parameter for bubble/slug flow
P1TBX			VX		Toi sensitivity parameter for bubble/slug flow
P1TBY			VY		Toi sensitivity parameter for bubble/slug flow
P1TBZ			VZ		Toi sensitivity parameter for bubble/slug flow
P1TOS	V	J		R	Toi sensitivity parameter for stratified flow
TOIFDT	V			R	Toi (1D) sensitivity parameter downstream quench front
TOZFDT			VZ		Toi (3D) sensitivity parameter downstream quench front
SP1ETO	V		N		Entrainment rate sensitivity parameter (Toi)
SP1DGTOI	V		N		Droplet diameter sensitivity parameter for Toi
SP1DGFDT	V		N		Droplet diameter sensitivity parameter for Toi downstream the quench front
SP1ENTV	V		N		Entrainment threshold velocity sensitivity parameter (Toi)
PQSH	Si	M	Si		liquid-interface heat transfer sensitivity parameter in case of Shah correlation
PQCH	Si		Si		liquid-interface heat transfer sensitivity parameter in case of Chen correlation PQCH must be equal to PPCH.
PQSHER	Si	M	Si		Liquid-interface heat transfer sensitivity parameter in case of Chen correlation with non condensable gas (modification of Sherwood number). PQSHER must be equal to PPSHER.
PQST	Si	M	Si		liquid-interface heat transfer sensitivity parameter for stratified flows.
DTMFS	Si	M	Si		Minimum stable Film temperature sensitivity parameter (bias)
SCOQLES	S	S			Source (source, accu, tee) injection term (QLE, mass transfer) parameter

#### 241.4.5 Additional variables for VOLUME element

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
LEVEL		R			surface elevation in a volume (m)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 695/851

SUBVOL	M			total volume of the sub-volumes ( $m^3$ )
SUBVMASS	M			total mass of the sub-volumes (kg)
ICONSERV	R			Flag to indicate use of conservative form of energy equation (1 if used, 0 otherwise)
LEVELMAX	R			Maximum elevation of lower and upper sub volumes interface (m)
PORNAMES	J			Names of the junction

#### 241.4.6 Variables for FLOMIXER model

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
IMIXSTAT		R			state of the flomixer model : (to be read on the “out-going” volume) IMIXSTAT = 1 if the model is disabled (by STOPMIX directive),= 2 if it is enabled (by STARTMIX directive) and = 3 if it is stopped (because of physical conditions)
DQMAXI		R			Maximal value of the asymmetry coefficient between incoming flow rates for which the incomplete mixture model can be applied
AGMAXI		R			Maximal value of void fraction for which the incomplete mixture model can be applied

#### 241.4.7 Variables for VFILM directive use

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
ICOND		R			VFILM Film condensation correlation flag 0: Nusselt – natural convection 1: Nusselt – computed velocity 2: Nusselt – velocity defined by user 3: Nusselt – velocity defined by law 4: Copain – computed velocity 5: Copain – velocity defined by user 6: Copain – velocity defined by law 7: Ushida
VGMEAN		R			Gas mean velocity used in Nusselt forced and CO-PAIN correlation (m/s)
IVCSTAT		R			VFILM special correlation activation flag : 1 =not activated, 2 = activated

#### 241.4.8 Variables for sensitivity calculation (volume only)

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
Ce document contient des résultats issus de travaux réalisés dans le cadre de l'accord CEA-EDF-AREVA NP-IRSN. Sa diffusion est soumise aux règles de cet accord.					

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A
	<b>Document technique DEN</b>	Page 696/851

CQMOIN	R			Energy transfer due to steam condensation from upper-volume to lower-volume sensitivity parameter
CQPLUS	R			Energy transfer due to steam vaporization from lower-volume to upper-volume sensitivity parameter
VDROPF	R			Drop fall velocity between upper and lower volume sensitivity parameter
PBTL	J			Betal sensitivity parameter
PBTG	J			Betag sensitivity parameter
PVBR	R			Rising of bubbles sensitivity parameter in lower sub-volume.

#### 241.4.9 Variables for sensitivity calculation (for TEE element only)

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SHENT	T				Sensitivity parameter of limit level used for liquid (for horizontal and upward Tee) or gas (for downward Tee) entrainment calculation and phase separation

#### 241.4.10 Variables for a boundary condition and rupture element

NAMEVAR	BC	RG	DEFINITION
PRESSURE	R	S	pressure (Pa)
LIQH	R	S	enthalpy of liquid (J/kg)
GASH	R	S	enthalpy of gas (steam + non condensable) (J/kg)
XiFRAC	R	S	mass fraction of non condensable number I
ALFA	R	S	void fraction
LIQTEMP	R	S	temperature of liquid (°C)
GASTEMP	R	S	temperature of gas (°C)
SATTEMP	R	S	saturation temperature (°C)
TSATPV	R	S	saturation temperature at vapor pressure (°C)
LIQDENS	R	S	density of liquid (kg/m <sup>3</sup> )
GASDENS	R	S	density of gas (kg/m <sup>3</sup> )
AVGDENS	R	S	average density (kg/m <sup>3</sup> )
LIQV	R	V	velocity of liquid (m/s)
GASV	R	V	velocity of gas (m/s)
LIQFLOW	R	V	liquid flow rate (kg/s)
LIQTOFLO		R	break liquid flow rate (kg/s)
GASFLOW	R	V	gas flow rate (kg/s)
GASTOFLO		R	break gas flow rate (kg/s)
STMFLOW	R	V	steam flow rate (kg/s)
STMTOFLO		R	break steam flow rate (kg/s)
TOTFLOW	R	V	total flow rate (kg/s)
MASTOFLO		R	break mass flow rate (kg/s)
XiFLOW	R	V	I <sup>th</sup> non condensable gas flowrate (kg/s)

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 697/851</a>

ENTHFLOW	R	R	enthalpy flow rate (J/kg/s)
COTABS	R		gravity × absolute elevation (m <sup>2</sup> /s <sup>2</sup> )
TIMERG		R	break opening time (s)

#### 241.4.11 Variables for external boundary condition BC3 BC4x BC5x and BC5XX

NAMEVAR	BC	DEFINITION
PEXT	R	pressure (Pa)
HLIQEXT	R	enthalpy of liquid (J/kg)
TLIQEXT	R	liquid temperature (°C)
UNDERSAT	R	temperature difference: TSAT(P) – TL outside the element (°C)
UNDERSPV	R	temperature difference: TSAT(PV) – TL outside the element (°C)
HGASEXT	R	enthalpy of gas (steam + non condensable) (J/kg)
TGASEXT	R	gas temperature (°C)
OVERHEAT	R	temperature difference: TG – TSAT(P) outside the element (°C)
OVERHEPV	R	temperature difference: TG – TSAT(PV) outside the element (°C)
ALFAEXT	R	void fraction
VLIQEXT	R	velocity of liquid (m/s)
JLIQEXT	R	liquid volumetric flux rate (m/s)
QLIQEXT	R	liquid flowrate (kg/s)
GAMEXT	R	slip ratio VG/VL
VGASEXT	R	velocity of gas (m/s)
JGASEXT	R	gas volumetric flowrate (m/s)
QGASEXT	R	gas flowrate (kg/s)
QTOTEXT	R	total flowrate (kg/s)
XEXTi	R	flow rate of the i <sup>th</sup> non condensable outside the element (kg/s)
LIQFRXj	R	activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the j <sup>th</sup> radio-chemical component in liquid phase outside the element
GASFRXj	R	activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the j <sup>th</sup> radio-chemical component in gas phase outside the element
PRESXi	R	partial pressure of the i <sup>th</sup> non condensable gas

#### Example

DOWNCO is an axial element

iq3 =	SCALAR	DOWNCO	12.3 ;
ip6 =	VECTOR	DOWNCO	7.6 ;
x1 =	VALUE	PRESSURE	DOWNCO iq3 ;
qt =	VALUE	TOTFLOW	DOWNCO ip6 ;
VOLDOWN is a volume			
rolinf =	VALUE	LIQDENS	voldown INF ;

 <p>DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b>  <b>SACLAY</b></p>		<i>DEN/DANS/DM2S/STMF/LMES/  RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 698/851

```

rov1 =           VALUE    GASDENS    voldown    SUP ;
zc =            VALUE    LEVEL      voldown ;
DWCO3D is a threed
x1 =           VALUE    PRESSURE   dwco3d     ip1 ;
ip1 being a scalar mesh number
v1 =           VALUE    LIQVZ      dwco3d     12 ;
z-liquid velocity on z-edge number 12

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 699/851

## 241.5 CCVs calculated in a JUNCTION

### Syntax

**x =                    VALUE                    NAMEVAR                    junci ;**

**NAMEVAR** : name of the variable  
**junci** : junction

#### Names of the variables which can be read:

UPRESSUR	: upstream pressure (Pa)
DPRESSUR	: downstream pressure (Pa)
ULIQH	: upstream liquid enthalpy (J/kg)
DLIQH	: downstream liquid enthalpy (J/kg)
UGASH	: upstream gas enthalpy (J/kg)
DGASH	: downstream gas enthalpy (J/kg)
UALFA	: upstream void fraction
DALFA	: downstream void fraction
ULIQV	: upstream velocity of liquid (m/s)
DLIQV	: downstream velocity of liquid (m/s)
UGASV	: upstream velocity of gas (m/s)
DGASV	: downstream velocity of gas (m/s)
UXiEXT	: upstream mass fraction of $I^{th}$ non condensable
DXiEXT	: downstream mass fraction of $I^{th}$ non condensable
LIQFLOW	: liquid flow rate (kg/s)
GASFLOW	: gas flow rate (kg/s)
TOTFLOW	: total flow rate (kg/s)
XiFLOW	: liquid flow rate of $I^{th}$ non condensable (kg/s)
ULIQFRi	: upstream liquid concentration of $I^{th}$ radio-chemical component (GBq/kg or kg of chemical components / kg of liquid)
UGASFRi	: upstream gas concentration of $I^{th}$ radio-chemical component (GBq/kg or kg of chemical components / kg of gas)
DLIQFRi	: downstream liquid concentration of $I^{th}$ radio-chemical component (GBq/kg or kg of chemical components / kg of liquid)
DGASFRi	: downstream gas concentration of $I^{th}$ radio-chemical component (GBq/kg or kg of chemical components / kg of gas)

**NB :** A junction is composed of 2 scalar points and a vector point. A scalar variable is taken upstream or downstream. A vector variable is taken at the vector point.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 700/851

<b>Example</b>
----------------

```

PIPE1 =      AXIAL      JA      USTREAM   JD      DSTREAM ;
PIPE2 =      AXIAL      JC      USTREAM   JA      DSTREAM ;
UPPRES =     VALUE      UPRESSUR  JA ;
QLIQ =       VALUE      LIQFLOW   JA ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 701/851

## 241.6 CCVs calculated in a ZONE

### Syntax

**x =                    VALUE                    NAMEVAR                    zone1;**

**NAMEVAR**                    : name of the variable  
**zone1**                    : zone objet (set of elements)

#### Names of the variables which can be read :

TOTMASS	: total mass of the fluid in the zone (kg)
LIQMASS	: liquid mass of the zone (kg)
MASERROR	: mass error (kg)
FLUIDNRJ	: total fluid energy in the zone (J/kg)
NRJERROR	: energy error (J/kg) NRJERROR is not available if a 3D element is defined within the circuit, its value is set to INF
XjMASS	: total mass of non-condensable gas j in the zone (kg)
XjMASERR	: mass error for non-condensable gas j in the zone (kg)
CWALLNRJ	: cumulated total increase of wall internal energy (J energy generated)
CWENERR	: energy error (J)
MASACTk	: mass/activity balance of radio-chemical component k in the zone (kg for chemical component, Gbq else)
XBAMOYk	: mean concentration of radio-chemical component k in the zone (kg/kg or Gbq/kg)

### Example

```
zmass =                    VALUE                    TOTMASS                    zone1 ;
zx2 =                    VALUE                    X2MASS                    zone1 ;
zmboron =                VALUE                    MASACT1                    zone1 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 702/851

## 241.7 CCVs calculated in a ZONE 3D

### Syntax

**x =                    VALUE                    NAMEVAR                    zone1;**

**NAMEVAR** : name of the variable  
**zone1** : zone of a threed element created by BILAN3D directive

#### Names of the variables which can be read :

LIQMASS	: liquid mass of the zone (kg)
STEAMASS	: vapor mass of the zone (kg)
GASMASS	: total gas mass of the zone (kg)
TOTMASS	: total mass of the zone (kg)
JONMASS	: cumulated mass injected/extracted in the zone through its junctions (kg)
FACMASS	: cumulated mass injected/extracted in the zone through its external (outer) faces (kg)
SOUmass	: cumulated mass injected/extracted in the zone by its gadgets (kg)
MASERROR	: mass error (kg)
FLUIDNRJ	: total fluid energy in the zone (J)
JONNRJ	: cumulated energy injected/extracted in the zone through its junctions (J)
FACNRJ	: cumulated energy injected/extracted in the zone through its external (outer) faces (J)
SOUNRJ	: cumulated energy injected/extracted in the zone by its gadgets (J)
XjMASS	: total mass of non-condensible gas j in the zone (kg)
XjJONMAS	: cumulated mass of non-condensible gas j injected/extracted in the zone through its junctions (kg)
XjFACMAS	: cumulated mass of non-condensible gas j injected/extracted in the zone through its external (outer) faces (kg)
XjSOUmas	: cumulated mass of non-condensible gas j injected/extracted in the zone by its gadgets (kg)
XjMASERR	: mass error for non-condensible gas j in the zone (kg)
CWALLNRJ	: cumulated total increase of walls of the zone internal energy (W energy generated)
CWALLGEN	: energy generated by the walls in the zone (W)
CTOTPOWR	: energy exchanged by the walls on the wet side (given to the fluid) in the zone (W)
	: energy lost by the walls (exchanged on dry side) in the zone
CTOTLOSS	(CTOTLOSS $\geq$ 0 if the power is lost by the wall, and $\leq$ 0 if the power is received by the wall) (W)
CWENERR	: energy error of the zone
MASACTk	: mass/activity balance of radio-chemical component k in the zone (kg for chemical component, Gbq for activity component)
MASDEPj	: total crystallized mass of radio-chemical component (boron) in the zone (kg)
XBAMOYk	: mean concentration of radio-chemical component k in the zone (kg/kg or Gbq/kg)

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 703/851

<b>Example</b>
----------------

```
zmass =      VALUE      TOTMASS    zone1 ;  
zx2 =        VALUE      X2MASS     zone1 ;  
zmboron =   VALUE      MASACT1   zone1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 704/851

## 241.8 CCVs calculated in a WALL

### Syntax

**x=                    VALUE                    NAMEVAR                    wall1                    obj2                    (ipm) ;**

<b>NAMEVAR</b>	: name of the variable
<b>wall1</b>	: wall or WALLCOM object
<b>obj2</b>	: argument defined in the table below.
<b>ipm</b>	: radial mesh number for the WALLTEMP or LAMBDA CCV.

The value of obj2 for each type of element is given in the following table :

s	wall axial mesh
m	upper sub-volume⇒ keyword SUP lower sub-volume⇒ keyword INF
0	nothing
	not available
irm	radial temperature node (ncell +1)
icm	cell number (ncell)

The names of variables which can be read are given in the following table :

### 241.8.1 General variables

NAMEVAR	Definition	obj2 for a 1D/3D	obj2 for a volume	Radial mesh num- ber
WALLWETT	wet wall temperature (°C)	s	m	
WALLDRYT	dry wall temperature (°C)	s	m	
WALLTEMP	at radial node number irm temperature(°C)	s	m	irm
LAMBDA	thermal conductivity (W/(m.K))	s	m	icm
WALLSURF	exchange surface of the mesh (m <sup>2</sup> )	s	m	
FOULING	fouling factor	0	0	
WALLGENR	generated power of the wall (W)	0	0	
TOTPOWET	exchanged power between wall and fluid (W)	0	0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 705/851

TOTLOSS	exchanged power between wall and outside (W) (TOTLOSS $\geq 0$ if the power is lost by the wall, and $\leq 0$ if the power is received by the wall)	0	0	
AGMINI	dry out criterion	0	0	
DELWALNR	cumulated total increase of wall internal energy (J)	0	0	
IECH	exchange zone index	s	m	
IWLLOS	indicator giving the kind of external condition 1 : explicit imposed flux is given by <i>Hext · Text</i> (refer to WALL definition or FLUMOD directive) 2 : explicit imposed flux is given by PHIEXT (refer to WALL definition) or default value (0.)	s	m	
IWHYD	connecting table between wall and element meshing. It gives the hydraulic scalar mesh number corresponding to the wall mesh	s	m	
PHIEXT	loss flux (imposed by CCV or WALL operator) ( $W/m^2$ )	s	m	
HEXT	external exchange coefficient (imposed by CCV, FLUMOD directive or WALL operator) ( $W/m^2/^\circ C$ )	s	m	
TEXT	external temperature (imposed by CCV, FLUMOD directive or WALL operator) ( $^\circ C$ )	s	m	
ZSW	Curvilinear coordinate of a wall axial mesh	s		
WSURFEXT	external exchange surface ( $m^2$ )	s	m	
PHIWET	total heat flux receiving by the fluid from the wet side ( $W/m^2$ )	s	m	
PHICR	critical heat flux ( $W/m^2$ )	s	m	
WALLNOMP	global power of the wall (W)	0	0	

#### 241.8.2 Variables for time and axial variation of power law

NAMEVAR	Definition	obj2 for a 1D/3D	obj2 for a volume	Radial mesh num- ber
ZPOWNR	axial normalized profile of power	s	m	
POWENR	power generated in the wall (W)	0	0	

#### 241.8.3 Variables for a WALLCOM type wall

NAMEVAR	Definition	obj2 for a 1D/3D	obj2 for a volume	Radial mesh num- ber
NSEG	number of 1D hydraulic meshes in front of the WALLCOM wall (WALLCOM object is only available for 1D element) For another WALL type, NSEG=0.	0		

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 706/851

## 241.8.4 Variables for sensitivity parameter

NAMEVAR	Definition	obj2 for a 1D/3D	obj2 for a volume	Radial mesh num- ber
PQPT	wall to fluid global heat transfer sensitivity parameter	s	m	
PQFDT	wall to fluid global heat transfer downstream the quench front sensitivity parameter	s		
P1K2FDT	place K2 reflooding parameter sensitivity parameter	0		
DNBR	global DNBR sensitivity parameter	s	m	
P1QPV	wall to gas heat transfer sensitivity parameter	s	m	
P1CHF	critical heat flux sensitivity parameter	s	m	
PPHBOI	film-boiling sensitivity parameter in case of no reflooding	s	m	
PPHBOR	film-boiling sensitivity parameter in case of reflooding	s	m	
PPHCOV	heat transfer for steam convection sensitivity parameter	s	m	
PPCH	Wall-interface heat transfer sensitivity parameter with Chen correlation. PPCH must be equal to PQCH (see VALUE for ELEMENT).	s	m	
PPSHER	Wall-interface heat transfer sensitivity parameter with Chen correlation. PPCH must be equal to PQCH (see VALUE for ELEMENT).	s	m	
PPHCFV	heat transfer for forced steam convection sensitivity parameter when there is no reflooding	s	m	
PPHCNV	heat transfer for natural steam convection sensitivity parameter when there is no reflooding	s	m	
PPHCFR	heat transfer for forced steam convection sensitivity parameter in case of reflooding	s	m	
PPHCNR	heat transfer for natural steam convection sensitivity parameter in case of reflooding	s	m	
PPHRDL	heat transfer for liquid radiation sensitivity parameter	s	m	
PPHRDV	heat transfer for steam radiation sensitivity parameter	s	m	
PCFLL	wall to fluid heat transfer sensitivity parameter in case of laminar forced convection	s	m	
PCFLT	wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection	s	m	
PCNLL	wall to fluid heat transfer sensitivity parameter in case of laminar natural convection	s	m	
PCNLT	wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection	s	m	
PCNB	wall to fluid heat transfer sensitivity parameter in case of nucleate boiling	s	m	
PQPICF	wall to liquid heat transfer sensitivity parameter in case of film condensation		m	
PQPVCF	wall to steam heat transfer sensitivity parameter in case of film condensation		m	
QPVBL	wall to steam heat flux sensitivity parameter in case of forced convection	s		

 <p>DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b>  SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/  RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 707/851

**WARNING :** To define a wall axial mesh, never use the directive SCALAR which refers to the hydraulic meshing. Wall axial mesh number is relative to the wall meshing and must be directly located by the user.

### Example

par1 belongs to an axial element

```
iq3 =           7      ;
tp1 =          VALUE    WALLWETT   par1      iq3 ;
tpa =          VALUE    WALLTEMP   par1      iq3      2 ;
par2 belongs to a volume
tp2 =          VALUE    WALLWETT   par2      SUP ;
tp14 =         VALUE    WALLTEMP   par2      SUP      2 ;
pow =          VALUE    WALLGENR  par2 ;
```



*DEN/DANS/DM2S/STMF/LMES/  
RT/12-040/A*

## Document technique DEN

Page 708/851

## 241.9 CCVs calculated in an EXCHANGER

## Syntax

**xval =**           **VALUE**           **NAMEVAR**     **exch**            **ip1**                (**ipm**) ;

<b>xval</b>	: value to be read
<b>NAMEVAR</b>	: name of the variable
<b>exch</b>	: exchanger name
<b>(or exch1 or exch2)</b>	(for the primary the name must be followed by "1", and for the secondary side by "2") <b>NB</b> : if the exchanger name is 8 characters long, the primary and secondary side names are given replacing the 8 <sup>th</sup> character respectively by 1 or 2
<b>ip1</b>	: wall axial mesh from the primary side point of view (s for axial mesh number, 0 for nothing)
<b>ipm</b>	: radial mesh number for the EXCHTEMP CCV variable

### **Names of the variables which can be read :**

### 241.9.1 General variables

NAMEVAR	Definition	ip1	ipm
EXCHPRIT	primary side temperature (°C)	s	
EXCHSECT	secondary side temperature (°C)	s	
EXCHTEMP	temperature of the radial mesh number ipm (°C)	s	ipm
WALLSURF	exchange surface of the mesh ( $m^2$ )	s	
FOULING	fouling factor	0	
WALLGENR	generated power of the wall (W)	0	
WALLNOMP	global power of the wall (W)	0	
TOTPOWET	exchanged power between wall and fluid (W)	0	
TOTLOSS	exchanged power between wall and outside (W)		
	(TOTLOSS $\geq 0$ if the power is lost by the wall, and $\leq 0$ if the power is received by the wall)	0	
DELWALNR	cumulated total increase of wall internal energy (J)	0	
IECH	Wall-fluid exchange index	s	
IWHYD	connecting table between wall and element meshing. It gives the hydraulic scalar mesh number corresponding to the wall mesh	s	
PHIWET	total heat flux received by the fluid from the wet side ( $W/m^2$ )	s	

### 241.9.2 Variables for time and axial variation of power law

<b>NAMEVAR</b>	<b>Definition</b>	<b>ip1</b>	<b>ipm</b>
POWENR	power generated in the wall (W)	0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 709/851

ZPOWNR	axial normalized profile of power	s	
--------	-----------------------------------	---	--

### 241.9.3 Variables for sensitivity parameter

NAMEVAR	Definition	ip1	ipm
PQPT	Wall to fluid global heat transfer sensitivity parameter	s	
PQFDT	Wall to fluid global heat transfer downstream the quench front sensitivity parameter	s	
DNBR	global DNBR sensitivity parameter	s	
P1QPV	wall to gas heat transfer sensitivity parameter	s	
P1CHF	critical heat flux sensitivity parameter	s	
PPHBOI	film-boiling sensitivity parameter in case of no reflooding	s	
PPHCOV	heat transfer for steam convection sensitivity parameter	s	
PPCH	Wall-interface heat transfer sensitivity parameter with Chen correlation. PPCH must be equal to PQCH (see VALUE for ELEMENT).	s	
PPSHER	Wall-interface heat transfer sensitivity parameter with Chen correlation. PPCH must be equal to PQCH (see VALUE for ELEMENT).	s	
PPHCFV	heat transfer for forced steam convection sensitivity parameter when there is no reflooding	s	
PPHCNV	heat transfer for natural steam convection sensitivity parameter when there is no reflooding	s	
PPHRDL	heat transfer for liquid radiation sensitivity parameter	s	
PPHRDV	heat transfer for steam radiation sensitivity parameter	s	
PCFLL	wall to fluid heat transfer sensitivity parameter in case of laminar forced convection	s	ipm
PCFLT	wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection	s	ipm
PCNLL	wall to fluid heat transfer sensitivity parameter in case of laminar natural convection	s	ipm
PCNLT	wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection	s	ipm
PCNB	wall to fluid heat transfer sensitivity parameter in case of nucleate boiling	s	
PQPICF	wall to liquid heat transfer sensitivity parameter in case of film condensation	s	
PQPVCF	wall to steam heat transfer sensitivity parameter in case of film condensation	s	

**WARNING :** To define an exchanger axial mesh, never use the directive SCALAR which refers to the hydraulic meshing. Wall axial mesh number is relative to the beginning of the wall and must be directly located by the user.

**WARNING:** the VALUE operator is applied:

1. on the primary side, if the exchanger name is followed by "1" (example: exch1),
2. on the secondary side, if the exchanger name is followed by "2" (example: exch2),
3. on the two sides, if the user only specifies the name of the exchanger (example: exch).

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 710/851

<b>Example</b>
----------------

```
exch1 : name of the exchanger
iq3 =           7 ;
tp1 =          VALUE      EXCHPRIT    exch1      iq3 ;
tpa =          VALUE      EXCHTEMP    exch1      iq3           2 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 711/851

## 241.10 CCVs calculated in a FUEL WALL or FUELPLAQ (FUEL PLATE)

### Syntax

**x =**           **VALUE**           **NAMEVAR**           **fuel1**           **obj4**           **ipm;**

<b>NAMEVAR</b>	: name for the variable
<b>fuel1</b>	: name of the fuelchar or fuelplaq object
<b>obj4</b>	: scalar point or nothing (for a global variable)
<b>ipm</b>	: OPTIONAL radial mesh number (used in WALLTEMP only)

#### Characteristics of obj4 and impl :

s	fuel axial mesh number
r	radial mesh number
0	nothing
	not available

#### Names of the variable which can be read :

### 241.10.1 Variables accessible at any time

#### 241.10.1.1 General variables

Variable	Description	obj4	ipm
ICOSTAT	: integer representing the state of thermo mechanics calculation for the wall -9999 : no thermo mechanics calculation is possible (FUELPLAQ) 1 : thermo mechanics calculation is not yet launched 2 : thermo mechanics calculation is running	0	
ICORAD	: integer representing the state of the wall with respect to the SCARFUEL option in FUEL operator -9999 : no SCARFUEL option has been defined 1 : STOPFUEL directive has been used 2 : RSETFUEL directive has been used	0	
ITYPEOX	: integer representing the oxidation law to be used for the wall 1 for CATHCART-PAWELL law describing the total oxygen consumption 2 for BAKER-JUST law 3 for CATHARE CATHCART-PAWELL law	0	

Ce document contient des résultats issus de travaux réalisés dans le cadre de l'accord CEA-EDF-AREVA NP-IRSN.

La diffusion est soumise aux règles de cet accord.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 712/851

WALLWETT	: temperature on wet side of the fuel rod (°C)	s	
WALLDRYT	: temperature on dry side of the wall (central temperature in case of a fuel rod) (°C)	s	
WALLTEMP	: temperature of the radial mesh number ipm (°C)	s	r
ZPOWNR	: axial normalized power of the fuel structure in the axial mesh : $\int_0^L ZPOWNR(Z) dZ = L$	s	
POWLIRE	: lineic residual power in the axial mesh (W/m)	s	
XNEUT	: fraction (between 0. and 1.) of neutrons power dissipated in the UO <sub>2</sub> pellet (1-XNEUT is dissipated in the fluid mesh)	s	
XRES	: fraction (between 0 and 1) of residual power dissipated in the fuel rod	s	
XRESMOD	: value given to XRES in MODXRES directive (-1 if not used or already used)	s	
POWXR	: value given to the ratio (fission power / fission power + residual power) in MODXRES directive (-1 if not used or already used)	s	
FOULING	: fouling factor	0	
WALLNOMP	: global power of the fuel structure (W)	0	
POWNEUT	: global point kinetics power or user external non residual power (W)	0	
POWRES	: residual power (W)	0	
COEFPNEU	: non residual power coefficient (only to be used for a FUELCHAR with CATAFUEL option)	0	
HGAPC	: Conductance of gas in the gap	s	
FLURADI	: Additional external oxide heat flow (W/m <sup>2</sup> )	s	
INSERT	: control rod group insertion in the core (m)	s	

#### 241.10.1.2 Variables for sensitivity parameters

Variable	Description	obj4	ipm
P1K2FDT	: place K2 reflooding parameter sensitivity parameter	0	
PQPT	: Wall to fluid global heat transfer sensitivity parameter	s	
PQFDT	: Wall to fluid global heat transfer downstream the quench front sensitivity parameter	s	
DNBR	: Global DNBR sensitivity parameter	s	
P1QPV	: Wall to gas heat transfer sensitivity parameter	s	
P1CHF	: Critical heat flux sensitivity parameter	s	
PPHBOI	: Film-boiling sensitivity parameter in case of no reflooding	s	
PPHBOR	: Film-boiling sensitivity parameter in case of reflooding	s	
PPHCOV	: Heat transfer for steam convection sensitivity parameter	s	
PPHCFV	: Heat transfer for forced steam convection sensitivity parameter when there is no reflooding	s	
PPHCNV	: Heat transfer for natural steam convection sensitivity parameter when there is no reflooding	s	
PPHCFR	: Heat transfer for forced steam convection sensitivity parameter in case of reflooding	s	
PPHCNR	: Heat transfer for natural steam convection sensitivity parameter in case of reflooding	s	
PPHRDL	: Heat transfer for liquid radiation sensitivity parameter	s	
PPHRDV	: Heat transfer for steam radiation sensitivity parameter	s	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 713/851

PCNB	: Wall to fluid heat transfer sensitivity parameter in case of nucleate boiling	s	
PCFLL	: Wall to fluid heat transfer sensitivity parameter in case of laminar forced convection	s	r
PCFLT	: Wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection	s	r
PCNLL	: Wall to fluid heat transfer sensitivity parameter in case of laminar natural convection	s	r
PCNLT	: Wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection	s	r
QPVBL	: Wall to steam heat flux sensitivity parameter in case of forced convection	s	

#### 241.10.2 Variables accessible at any time only for FUEL FUELCHAR object

UO2COND	UO2 pellet conductivity (W/m/K)	0	0
GAPCOND	Gap conductivity (W/m/K)	0	0
CLADCOND	Cladding conductivity (W/m/K)	0	0
OXIICOND	Internal oxide layer conductivity (W/m/K)	0	0
OXIECOND	External oxide layer conductivity (W/m/K)	0	0

#### 241.10.3 Variables accessible after GONEUT directive only for FUEL or FUELPLAQ objects

REACTMOD	Moderator anti-reactivity in \$ of the FUELCHAR	0	
REACTDOP	Doppler anti-reactivity in \$ of the FUELCHAR	0	
REACTBOR	Boron anti-reactivity in \$ of the FUELCHAR	0	
REACTREF	Reflector anti-reactivity in \$ of the FUELCHAR	0	
CORMOY	Average density of the coolant (kg/m <sup>3</sup> )	0	
COTMOY	Average temperature of the fuel (°C)	0	

#### 241.10.4 Variables accessible after GOFUEL directive only for FUELCHAR elements

##### 241.10.4.1 General variables

INDRUP	: flag to indicate if rupture has occurred	0	
NODRUP	: node where the rupture has occurred	0	
COAGMAX	: maximum value of void fraction along the fuel structure	0	
IMODNEUT	: value giving the kind of the FUELCHAR power definition 1000 : power is given by the user through law (user internal definition) 1001 : power is given by Cathare through CORE element (Cathare definition) 1002 : power is given by the user through CCV (user external definition) 1003 : special option only to be used for a fuel stand alone computation	0	
PRESSURE	: gas pressure in the gap (Pa)	0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 714/851

UO2CTEMP	: UO2 fuel central temperature in the core (°C)	s	
UO2STEMP	: UO2 fuel temperature on the surface (°C)	s	
UO2TEMP	: radial average UO2 fuel temperature (°C)	s	
UO2MEAN	: surface average UO2 fuel temperature (°C)	s	
CLADINTT	: internal temperature of the fuel cladding (°C)	s	
CLADEXTT	: external temperature of the fuel cladding (°C)	s	
CLADAVGT	: average temperature of the fuel cladding (°C)	s	
CLADRADI	: internal radius of the fuel cladding (m)	s	
OXIDEXTT	: temperature of the external oxide layer (°C)	s	
POWERoxy	: power generated by cladding oxidation (W/m <sup>3</sup> )	s	
POWERoxe	: power generated by cladding oxidation on external face (W/m)	s	
POWERoxi	: power generated by cladding oxidation on internal face (W/m)	s	
UO2RADIU	: external radius of UO2 pellet	s	
CLADRADM	: average radius of the fuel cladding (m)	s	
CLADTHIC	: cladding thickness (m)	s	
INOXTHIC	: internal oxide thickness (m)	s	
EXOXTHIC	: external oxide thickness (m)	s	
RAYONM	: external oxide internal radius (m)	s	
RAYONP	: external oxide external radius (m)	s	
XNEUMOD	: value given to XNEUT in MODXNEUT directive (-1 if not used or already used)	s	
POWXN	: value given to the ratio (fission power / fission power + residual power) in MODXNEUT directive (-1 if not used or already used)	s	
RAYCOLD	: cold radius of the pellet. If it is different from 0 this value is used to modify the UO2 density $\rho = \rho_{ini} \cdot \frac{RAYCOLD^2}{RAY^2}$ with RAY= actual radius of the pellet and $\rho_{ini} = 10950 \text{ kg/m}^3$	0	
RUPTFRAG	: real value giving the scalar mesh number where the fragile rupture will occur when physical conditions will be fulfilled	0	
OXRATE	: calculated oxidation rate (use of OXRATE directive needed)	s	
RELOCDGA	: Diameter of fuel fragments used to calculate the residual gap	0	
RELOCDCO	: Diameter of fuel fragments used to calculate the equivalent thermal conductivity	0	
RELOCTXO	: Volume fraction of balloon filled by fuel after relocation	0	
RELOCGAP	: Value of the gap calculated by relocation model and imposed after the cladding burst at the rupture location	0	
RELOCPWR	: Value of the power coefficient calculated by relocation model after the cladding burst at the rupture location	0	
GAPCOND	: Value of the conductivity in the gap	s	
LAMBDUO2	: Value of UO2 pellet conductivity	s	r

#### 241.10.4.2 Variables for sensitivity parameters

COEFLAMB	: pellet conductivity sensitivity parameter	s	
CTOTLAMB	: UO2 conductivity sensitivity parameter	0	
COEFALRU	: sensitivity parameter of the rupture deformation	0	
COEFSTRU	: stress rupture sensitivity parameter	0	
COEFHGAS	: gap conductance sensitivity parameter	0	
COEFEMI	: cladding emissive sensitivity parameter	0	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 715/851

COEFPRS	: residual power sensitivity parameter	0	
COEFROCP	: cladding $\rho \cdot Cp$ sensitivity parameter	0	
COEFCP	: UO2 heat capacity sensitivity parameter	0	
COEFRHO	: UO2 density sensitivity parameter	0	
CLADLAMB	: clad conductivity sensitivity parameter	0	
CLADROCP	: cladding $\rho \cdot Cp$ sensitivity parameter	0	
FLUAGE	: creep rate sensitivity parameter	0	
COXLAW	: internal and external oxide layer thickness rate sensitivity parameter	0	
COXNRJ	: internal and external oxide layer volume power sensitivity parameter	0	

**Example**

```
ip4 =          7 ;
xm1 =          VALUE      CLADAVGT    fuel1      ip4 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 716/851

## 241.11 CCVs calculated in a reflooding element (REFLCHAR)

### Syntax

**x =                    VALUE                    NAMEVAR                    refl1;**

**NAMEVAR**                    : name for the variable  
**refl1**                        : name of the reflchar

#### Names of variables which can be read :

### 241.11.1 General variables

QFLEVEL	: quench front level (m)
QFVELOC	: quench front velocity (m/s)
QFIND	: 1D/2D reflooding index
QFZSUP	: upstream quench front scalar node level (m)
QFZSDO	: downstream quench front scalar node level (m)
QFTWUP	: upstream quench front scalar node wall temperature (°C)
QFTWD0	: downstream quench front scalar node wall temperature (°C)
QFTBDO	: downstream quench front scalar node burn-out temperature (°C)
QFTMDO	: downstream quench front scalar node film boiling temperature (°C)
QFZSUPO	: initial upstream quench front scalar node level (m)
QFZSDOO	: initial downstream quench front scalar node level (m)
QFTWUPO	: initial upstream quench front scalar node wall temperature (°C)
QFTWDOO	: initial downstream quench front scalar node wetted temperature (°C)
QFTBDOO	: initial downstream quench front scalar node burn-out temperature (°C)
QFTMDOO	: initial downstream quench front scalar node film boiling temperature (°C)

### 241.11.2 Variables for sensitivity parameters

CTOTLAMB	: pellet conductivity sensitivity parameter
COEFROCP	: <i>pCp</i> pellet sensitivity parameter
CLADLAMB	: cladding conductivity sensitivity parameter
CLADROCP	: cladding <i>pCp</i> sensitivity parameter

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 717/851

## 241.12 CCVs calculated in an ACCUMULATOR

### Syntax

```
x =      VALUE      NAMEVAR    accu1;
```

**NAMEVAR** : name of the variable  
**accu1** : accumulator name

#### Names of the variables which can be read :

PRESSURE	: accumulator pressure (Pa)
LIQH	: accumulator liquid enthalpy (J/kg)
GASVOL	: volume of gas of the accumulator (m <sup>3</sup> )
LIQVOL	: volume of liquid of the accumulator (m <sup>3</sup> )
LIQMASS	: water mass of the accumulator (kg)
GASMASS	: gas mass of the accumulator (kg)
GASFLOW	: flow rate of gas injected by the accumulator (kg/s)
LIQFLOW	: flow rate of liquid injected by the accumulator (kg/s)
TOTFLOW	: total flow rate injected by the accumulator (kg/s)
EXPANSIO	: gas expansion coefficient
NITMASFR	: mass fraction of NITROGEN diluted in the water of the accumulator
LIQTEMP	: accumulator liquid temperature (°C)
ALOS	: accumulator head loss coefficient
ICLOS	: indicator related to the discharge of the non-condensable gas declared in the ACCU operator. The value 1 (default value) corresponds to the discharge of the non condensable gas after total evacuation of water (see NOCLOSE optional keyword for the ACCU operator). The value 0 corresponds to the closure of the accumulator after total evacuation of water (without discharge of the non condensable gas).
VALCOEFA	: coefficient A of the valve hysteresis model (Pa)
LIQFRAi	: (1≤i≤12) Concentration of chemical element #i in the liquid phase (kg/kg)

### Example

```
xm1 =      VALUE      LIQMASS    accu1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 718/851

## 241.13 CCVs calculated in a BREAK

### Syntax

**x = NAMEVAR NAMEVAR break1;**

**NAMEVAR** : name of the variable  
**break1** : break name

#### Names of the variables which can be read :

<b>IPSINT</b>	: scalar mesh number the break is linked to
<b>TCR</b>	: flag to indicate if the flow type : TCR = 0 sub-sonic condition TCR = 1 sonic condition
<b>placeCOTE</b>	: relative elevation of the gadget in the pipe (m)
<b>TOTFLOW</b>	: break flow rate (kg/s)
<b>LIQFLOW</b>	: liquid flow rate (kg/s)
<b>GASFLOW</b>	: gas flow rate (kg/s)
<b>STMFLOW</b>	: steam flow rate (kg/s)
<b>XiFLOW</b>	: flow rate of the $i^{th}$ non condensable (kg/s)
<b>ENTHFLOW</b>	: enthalpy flow (J/s)
<b>SLIPRATE</b>	: VG/VL
<b>VALVSECT</b>	: cross-section of the break ( $m^2$ )
<b>XLFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in liquid phase at the break.
<b>XGFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in gas phase at the break.
<b>LIQFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of liquid) of the i-th radio-chemical component in liquid phase at the break.
<b>GASFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of gas) of the i-th radio-chemical component in gas phase at the break.
<b>QTFLOWi</b>	: flow of the i-th radio-chemical component (GBq/s or kg/s)
<b>MASACTi</b>	: mass/activity balance of the i-th radio-chemical component (kg for chemical component, Gbq for activity component)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 719/851

## 241.14 CCVs calculated in a CANDLE

### Syntax

**x =                    VALUE                    NAMEVAR                    candle1;**

**NAMEVAR**                    : name of the variable  
**candle1**                    : name of the candle

#### Names of the variables which can be read :

### 241.14.1 General variables

<b>ENECANDL</b>	: flag to indicate if the candle is enabled (1 = on, 0 = off)
<b>CTYPCN</b>	: type of candle

### 241.14.2 Variables for 1-D or 3-D element

<b>LIQPOWER</b>	: Power (W) directly injected into the bulk liquid phase without changing the interface heat flux.
<b>GASPOWER</b>	: Power (W) directly injected into the bulk gas phase without changing the interface heat flux.
<b>INTERLIQ</b>	: Power (W) directly injected into the interface on the liquid side.
<b>INTERGAS</b>	: Power (W) directly injected into the interface on the gas side.

### 241.14.3 Variables for 0-D element

<b>INJECVOL</b>	: Power (W) injected directly into the bulk dominant phase of the sub-volume addressed by the CANDLE (depending on level in the volume and on the elevation of the candle).
-----------------	---

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 720/851</a>

## 241.15 CCVs calculated in a neutronic sub-module (CORE)

### Syntax

**x =                    VALUE                    NAMEVAR                    core1;**

**NAMEVAR**                    : name for the variable  
**core1**                    : name of the core

#### Names of variables which can be read :

PNCHARGE	: Ratio between neutron power at current time and neutron power at initial time (%)
POWER	: Total core power (W)
RESPOWER	: Core residual power (W)
FISPOWER	: Fission power (W)
REACTIVE	: Core reactivity (\$ i.e. pcm/BETA)
REACTEXT	: External reactivity inserted in the core region (\$)
REACTMOD	: Moderator anti-reactivity in the core region (\$)
REACTDOP	: Fuel temperature (Doppler) anti-reactivity in the core region (\$)
REACTBOR	: Boron concentration anti-reactivity in the core region (\$)
REACTREF	: Reflector anti-reactivity in the core region (\$)
SOURCNEU	: Power increase due to external neutron source (W/s)
COREDENS	: Average density of the coolant in the core region (kg/m <sup>3</sup> )
CORETEMP	: Average temperature of the fuel in the core region (°C)

### Example

**x1 =                    VALUE                    PNCHARGE                    core1 ;**

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 721/851

## 241.16 CCVs calculated in a Piqxxx gadget

### Syntax

**x =                    VALUE                    NAMEVAR                    piq1 ;**

**NAMEVAR** : name of the variable  
**piq1** : gadget name (PIQBREK, PIQSEB, PIQSOUP, PIQVANNE or PIQREV)

#### Names of the variables which can be read:

### 241.16.1 Variables for all PIQxxx gadgets

#### 241.16.1.1 Variables for localization and state

<b>IPSINT</b>	: scalar mesh number the gadget is linked to
<b>BVSISTAT</b>	: state of the PIQxxx BVSISTAT = 1 if the PIQxxx is connected, 0 otherwise
<b>placeCOTE</b>	: elevation of the gadget in the element (m)
<b>COTABS</b>	: absolute elevation of the gadget in the circuit (m)
<b>TCR</b>	: flag giving the flow type : TCR = 0 sub-sonic condition TCR = 1 sonic condition

#### 241.16.1.2 Variables for flows through the PIQxxx element

<b>TOTFLOW</b>	: total flow rate (kg/s)
<b>LIQFLOW</b>	: liquid flow rate (kg/s)
<b>STMFLOW</b>	: steam flow rate (kg/s)
<b>GASFLOW</b>	: gas flow rate (kg/s)
<b>XiFLOW</b>	: flow rate of the <i>i<sup>th</sup></i> non condensable (kg/s)
<b>ENTHFLOW</b>	: enthalpy flow (J/s)
<b>ENTLFLOW</b>	: liquid enthalpy flow (J/s)
<b>ENTGFLOW</b>	: gas enthalpy flow (J/s)
<b>SLIPRATE</b>	: VG/VL
<b>XLFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the <i>i</i> -th radio-chemical component in liquid phase.
<b>XGFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the <i>i</i> -th radio-chemical component in gas phase.
<b>QTFLOWi</b>	: flow of the <i>i</i> -th radio-chemical component (GBq/s or kg/s)

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 722/851

MASACTi	: mass/activity balance of radio-chemical component i (kg for chemical component, GBq else)
---------	--

#### 241.16.1.3 Variables related to the outgoing fluid

PRESSURE	: pressure inside the element (Pa)
LIQTEMP	: liquid temperature (°C)
GASTEMP	: gas temperature (°C)
LIQH	: liquid enthalpy (J/kg)
GASH	: gas enthalpy (J/kg)
ALFA	: void fraction
LIQDENS	: liquid density (kg/m <sup>3</sup> )
GASDENS	: gas density (kg/m <sup>3</sup> )
AVGDENS	: average density (kg/m <sup>3</sup> )
AVGENTH	: average enthalpy (J/kg)
XiFRACt	: mass fraction of the i-th non condensable gas
PRESXi	: partial pressure of the i-th non condensable gas (Pa)
LIQFRAi	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of liquid) of the i-th radio-chemical component in liquid phase
GASFRAi	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of gas) of the i <sup>th</sup> radio-chemical component in gas phase

#### 241.16.1.4 Variables used in case of injection (for reversible gadgets)

Additional values (which are the user imposed values) related to the external fluid :

PEXT	: pressure (Pa)
ALFAEXT	: void fraction
XIEXT	: mass fraction of i-th non condensable gas
HLINJ	: liquid enthalpy (J/kg)
HGINJ	: gas enthalpy (J/kg)
TLINJ	: liquid temperature (°C)
TGINJ	: gas temperature (°C)
GASFRXi	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the i <sup>th</sup> radio-chemical component in gas phase
LIQFRXi	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the i <sup>th</sup> radio-chemical component in liquid phase

Example : if imposing TLIQEXT (see WRITE directive ), TLINJ = TLIQEXT

if imposing HLIQEXT (see WRITE directive ), TLINJ = TL(P,HLIQEXT)

And for Enthalpies :

if imposing HLIQEXT, HLINJ = HLIQEXT

if imposing TLIQEXT, HLINJ = HL(P,TLIQEXT)

And the same for gas values

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 723/851

## 241.16.2 Specific additional variables for PIQBREK

TOPEN	: instant when the PIQBREK has been opened (s)
DTOPEN	: duration for opening the PIQBREK (s)
SECTMAX	: maximum cross area of the PIQBREK ( $m^2$ )
SECTBREC	: rate of opening (effective cross area/maximum cross area)

## 241.16.3 Specific additional variables for PIQSOUP

REALSEC	: computed section ( $m^2$ )
REALPU	: normalised section of the control rod with failure
IFAILURE	: index of the failure (0 if no failure)
XFAILURE	: failure rate
SECTMAX	: maximum cross area of the PIQSOUP ( $m^2$ )
POPN	: opening pressure (Pa)

## 241.16.4 Specific additional variables for PIQSEB

EQUIVPU	: equivalent position of the control rod
EQUIVSEC	: computed section ( $m^2$ )
SECTMAX	: maximum cross area of the PIQSEB ( $m^2$ )
POPN	: opening pressure (Pa)
PCLOSE	: closing pressure (Pa)

And, for each SEBIM included in the PIQSEB :

**x =                    VALUE                    NAMEVAR            sebim1 ;**

**NAMEVAR**                    : name of the variable  
**Sebim1**                    : SEBIM name

IFAILURE	: index of the failure (0 if no failure)
XFAILURE	: failure rate (PU)
REALSEC	: computed section ( $m^2$ )
REALPU	: normalised section of the control rod with failure
IFORCE	: (only for Cathare/simulator coupling) value is 1 if the type 1 Cathare failure (spurious lift) is also a failure for the simulator, 0 if not

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 724/851

## 241.16.5 Specific additional variables for PIQVANNE

EQUIVPU	: equivalent position of the control rod
EQUIVKM	: equivalent singularity
EQUIVSEC	: computed section ( $m^2$ )
ROREF	: specific mass of the fluid under nominal conditions ( $kg/m^3$ )
XTVAN	: the default value is 0.1 for CHECK VALVES and 0.6804 ( $= \frac{DP}{P} = 0.84 \cdot Cf^2$ ) for CONTROL VALVES

For each VALVE included in the PIQVANNE :

**x =                    VALUE                    NAMEVAR                    valve1;**

**NAMEVAR**                    : name of the variable  
**valve1**                    : VALVE name

PU	: given control rod position
IFailure	: index of the failure (0 if no failure)
XFailure	: failure rate (PU)
REALKM	: real singularity with failure
REALPU	: real control rod position with failure

And for the CHECKVALVE included in the PIQVANNE :

**x =                    VALUE                    NAMEVAR                    chval1;**

**NAMEVAR**                    : name of the variable  
**chval1**                    : CHECKVALVE name

IFailure	: index of the failure (0 if no failure)
XFailure	: failure rate (PU)
REALKM	: real singularity with failure
REALPU	: real control rod position with failure

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 725/851

#### 241.16.6 Specific additional variables for PIQREV

SECT	: section ( $\text{m}^2$ )
PSATTLIN	: saturation pressure at liquid temperature in the element (Pa)
ALFAC	: threshold void fraction to start gas entrainment

#### 241.16.7 Specific additional variables for PIQARE

SECT	: section ( $\text{m}^2$ )
ALFAC	: threshold void fraction to start gas entrainment
RATINI	: ARE overflow rate during steady state calculation (value between 0 and 1)
CONST	: fitting constant
SECASP	: section to use to evaluate velocity in the steam generator at the injection point for the model ( $\text{m}^2$ )
TXDEB	: ARE overflow rate (value between 0 and 1)
ARESTAT	: flag to indicate if the model for ARE overflow is used (1 if it is used, 0 otherwise)
AREFLOW	: ARE nozzle flow rate ( $\text{kg/s}$ )

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 726/851

## 241.17 CCVs calculated in a 0D PUMP

### Syntax

**x =                    VALUE                    NAMEVAR                    pump1;**

**NAMEVAR** : name of the variable  
**pump1** : name of the PUMPCHAR

#### Names of the variables which can be read :

### 241.17.1 General variables

PMPSPEED	: pump rotating speed (rad/s)
CLICK	: 'fall of the arm latches' indicator (1: arm latches on , 0 : no)
BLOCK	: pump locking indicator (1 for a locked pump, 0 for not locked)
MTORQUE	: pump torque (N.m)
PMPELEV	: pump height (manometric height*gravity ) (m <sup>2</sup> /s <sup>2</sup> )
PMPHDEG	: pump height degradation (between 0. and 1.)
PMPCDEG	: pump height degradation due to cavitation (between 0. and 1.)

### 241.17.2 Variables for failure

IFailure	: Blocked rotor indicator (0 if it is free , 1 if it is blocked) (indicator of BLKROTOR directive use)
XFailure	: Multiplicative coefficient applied to head loss coefficient imposed in case of failure (between 0. and 1.)
INERTIA	: Inertia momentum of the pump (kg.m <sup>2</sup> )

### 241.17.3 Variables for asynchronous motor model

INTENSIT	: stator line current (A)
FACTPUIS	: cos ( $\Phi$ ) power factor
VNOMIN	: supply voltage (V)
FREQALIM	: nominal supply frequency (Hz)
VNOMALIM	: nominal supply voltage (V)

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 727/851

## 241.17.4 Variables for sensitivity parameter

CGRAVH	: Pump height sensitivity parameter
--------	-------------------------------------

<b>Example</b>
----------------

v1 =                    VALUE                    PMPSPEED            pump1 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 728/851

## 241.18 CCVs calculated in a SENSOR

### Syntax

**x =                    VALUE                    NAMEVAR                    sensor;**

**NAMEVAR**                    : name of the variable  
**sensor**                    : sensor name

#### Names of the variables which can be read :

### 241.18.1 Variables for Temperature sensor

TEMP	: fluid temperature (°C)
------	--------------------------

### 241.18.2 Variables for Pressure sensor

PRESSURE	: fluid Pressure (Pa)
SRCOTE	: elevation of the sensor in the element (m)
COTEABS	: absolute elevation of the sensor in the circuit (m)

### 241.18.3 Variables for Flowrate sensor

LIQMFLOW	: liquid mass flow rate (kg/s)
GASMFLOW	: gas mass flow rate (kg/s)
LIQVFLOW	: liquid volume flow rate (m <sup>3</sup> /s)
GASVFLOW	: gas volume flow rate (m <sup>3</sup> /s)

### 241.18.4 Variables for SIPA simulator Sensor

VL	: liquid velocity (m/s)
VG	: gas velocity (m/s)
LIQDENS	: liquid density (kg/m <sup>3</sup> )
GASDENS	: gas density (kg/m <sup>3</sup> )
ALFA	: void fraction
UMALFA	: 1. – ALFA

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 729/851

## 241.18.5 Variables for Activity sensor

XBAMOYj	: average activity of the $j^{th}$ radio-chemical component (GBq/kg)
LIQFRAj	: activity of the $j^{th}$ radio-chemical component (GBq/kg) in the liquid phase
GASFRAj	: activity of the $j^{th}$ radio-chemical component (GBq/kg) in the gas phase

## 241.18.6 Variables for ACTISIPA Activity sensor

XBAMOYj	: average activity of the $j^{th}$ species (GBq/m <sup>3</sup> )
---------	--

## 241.18.7 Variables for QACTSIPA Activity sensor

XBFLOWj	: average flow rate activity of the $j^{th}$ species (GBq/s)
---------	--

## 241.18.8 Variables for ULTRASON Sensor and for the measure of the level in the hot leg

PRESSURE	: pressure in the fluid (Pa)
ALFA	: void fraction (PU)
LIQTEMP	: liquid temperature (°C)
GASTEMP	: gas temperature (°C)
XjFRACT	: mass fraction of the $j^{th}$ non condensable
TXSTRAT	: stratification coefficient
TXENT	: entrainment coefficient

## 241.18.9 Variables for SWLLEVEL Sensor used for the measure of the swell level

SWLLEVEL	: Swell level according to the bottom of the considered zone (first zonedefined 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)
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)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 730/851

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

<b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 731/851</a>

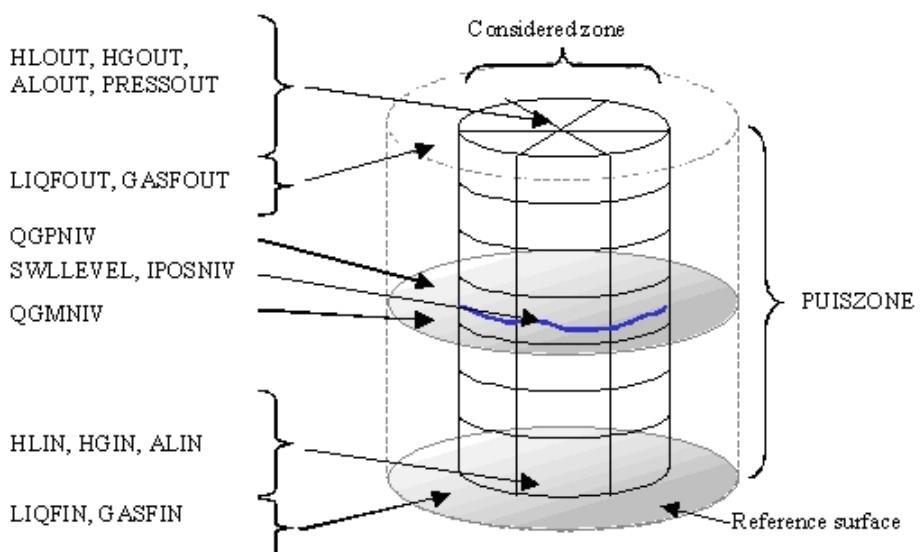


Figure 241.18.1: VALUE : SWLLEVEL Sensor for the measure of the swell level

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 732/851

## 241.19 CCVs calculated in a SINK

### Syntax

**x =                    VALUE                    NAMEVAR                    sink1 ;**

**NAMEVAR** : name of the variable  
**sink1** : sink name (SINK, SINKRRI)

#### Names of the variables which can be read :

### 241.19.1 General variables

<b>IPSINT</b>	: scalar mesh number carrying the sink
<b>COTE</b>	: relative elevation of the gadget in the element (m)
<b>TCR</b>	: flag giving the flow type : TCR = 0 sub-sonic condition TCR = 1 sonic condition
<b>TOTFLOW</b>	: sink flow rate (kg/s)
<b>LIQFLOW</b>	: liquid flow rate (kg/s)
<b>GASFLOW</b>	: gas flow rate (kg/s)
<b>STMFLOW</b>	: steam flow rate (kg/s)
<b>XiFLOW</b>	: flow rate of the $i^{th}$ non condensable (kg/s)
<b>ENTHFLOW</b>	: enthalpy flow (J/s)
<b>ENTLFLOW</b>	: liquid enthalpy flow (J/s)
<b>ENTGFLOW</b>	: gas enthalpy flow (J/s)
<b>SLIPRATE</b>	: VG/VL
<b>XLFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in liquid phase.
<b>XGFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in gas.
<b>QTFLOWi</b>	: flow of the i-th radio-chemical component (GBq/s or kg/s)
<b>MASACTi</b>	: mass/activity balance of radio-chemical component i (kg for boron, Cu else)
<b>LIQFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of liquid) of the i-th radio-chemical component.
<b>GASFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of gas) of the i-th radio-chemical component.

### 241.19.2 Additional variables for a sink-safety valve

<b>VALVSECT</b>	: full-opening cross-section of the valve ( $m^2$ )
<b>VALSECC</b>	: current cross-section of the valve ( $m^2$ )
<b>VALVPRES</b>	: valve calibration pressure (Pa)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 733/851

### 241.19.3 Additional variables for a RRI sink (type SINKRRI)

#### 241.19.3.1 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	: Power exchanged in LPSI/component cooling system(RRI) exchanger (W)

#### 241.19.3.2 Variables for the Containment Spray System (EAS)

FLOWEAS	: Liquid flow rate of the spray (containment spray system source/ EAS source) (kg/s)
TEMPEAS	: Temperature of the spray injected liquid (°C)
POWEAS	: Power exchanged in containment spray system/component cooling system (EAS/RRI) exchanger (W)

#### 241.19.3.3 Variables at the Component Cooling System (RRI)

FLOWRRI	: Flow rate (at RRI/SEC exchanger outlet) (kg/s)
TEMPRRIF	: Liquid temperature in the RRI circuit at the RRI/SEC exchanger inlet (°C)
TEMPRRIC	: Liquid temperature in the RRI circuit at the RRI/SEC exchanger outlet (°C)
TEMPREAS	: Liquid temperature in the RRI circuit at the EAS/RRI exchanger outlet (°C)
TEMPRISB	: Liquid temperature in the RRI circuit at the ISBP/RRI exchanger outlet (°C)
XREAS	: Rate of flow rate in EAS/RRI exchanger (value between 0. and 1.) : $Q(EAS/RRI) / [ Q(EAS/RRI) + Q(ISBP/RRI) ]$
FLOWAUX	: Additional flow rate extracted from RRI (other than EAS and ISBP) (kg/s)
POWAUX	: Additional power extracted from RRI (other than EAS and ISBP) (W)

#### 241.19.3.4 Variables for the Essential Service Water System (SEC)

FLOWSEC	: Flow rate in RRI/SEC exchanger (kg/s)
TEMPSECF	: Liquid temperature at the RRI/SEC exchanger inlet (°C)
TEMPSECC	: Liquid temperature at the RRI/SEC exchanger outlet (°C)
POWSEC	: Heat flux exchanged in SEC/RRI exchanger (W)

#### 241.19.3.5 Variables for the Raw Water system (SEB)

FLOWSEB	: Flow rate in EAS/SEB exchanger (kg/s)
TEMPSEBF	: Liquid temperature at the EAS/SEB exchanger inlet (°C)
TEMPSEBC	: Liquid temperature at the EAS/SEB exchanger outlet (°C)
POWSEB	: Heat flux exchanged in EAS/SEB exchanger (W)

#### Example

```
xm1 =      VALUE      ENTHFLOW    sink1 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 734/851

## 241.20 CCVs calculated in a SOURCE

### Syntax

**x =                    VALUE                    NAMEVAR                    source1;**

**NAMEVAR**                    : name of the variable  
**source1**                    : source name (SOURCE, SOURIS)

#### Names of the variables which can be read:

### 241.20.1 General variables

<b>IPSINT</b>	: scalar mesh number carrying the source
<b>ITLSOU</b>	: flag to indicate the law type for a liquid source ( 1=HL, 2=TL, 3=UNDERSAT, 4=UNDERSPV )
<b>ITGSOU</b>	: flag to indicate the law type for a steam source( 1=HG, 2=TG, 3=OVERHEAT, 4=OVERHEPV )
<b>COTE</b>	: relative elevation of the gadget in the element (m)
<b>TCR</b>	: flag giving the flow type : TCR = 0 sub-sonic condition TCR = 1 sonic condition
<b>TOTFLOW</b>	: source flow rate (kg/s)
<b>LIQFLOW</b>	: liquid flow rate (kg/s)
<b>GASFLOW</b>	: gas flow rate (kg/s)
<b>STMFLOW</b>	: steam flow rate (kg/s)
<b>XiFLOW</b>	: flow rate of the $i^{th}$ non condensable (kg/s)
<b>ENTHFLOW</b>	: enthalpy flow (J/s)
<b>SLIPRATE</b>	: VG/VL
<b>LIQH</b>	: liquid enthalpy (J/kg)
<b>GASH</b>	: gas enthalpy (J/kg)
<b>LIQTEMP</b>	: liquid temperature of the source ( $^{\circ}$ C)
<b>GASTEMP</b>	: gas temperature of the source ( $^{\circ}$ C)
<b>ALFA</b>	: void fraction
<b>XLFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in liquid phase.
<b>XGFLOWi</b>	: radio-chemical flow (GBq/s or kg/s) of the i-th radio-chemical component in gas.
<b>QTFLowi</b>	: flow of the i-th radio-chemical component (GBq/s or kg/s)
<b>MASACTi</b>	: mass/activity balance of radio-chemical component i (kg for boron, GBq else)
<b>LIQFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of liquid) of the i-th radio-chemical component.
<b>GASFRAi</b>	: radio-chemical concentration (GBq/kg or kg of chemical components / kg of gas) of the i-th radio-chemical component.

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 735/851

## 241.20.2 Additional variables for a SOURIS type source

RESPOWER	: Core residual power (W)
CONRATE	: Rate of condensation in containment
Security injection characteristics :	
POSIRIS	: Position of the break (m)
FLOWRISF	: Cold leg extra liquid flow rate (kg/s)
FLOWRISC	: Hot leg extra liquid flow rate (kg/s)
TLRIS	: Temperature of extra water (same in hot and cold legs) (°C)

### Example

```
xml1 =           VALUE       LIQFLOW     sour1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 736/851

## 241.21 CCVs calculated in a 0D STEAM GENERATOR

### Syntax

**x =                    VALUE                    NAMEVAR                    sg1 ;**

**NAMEVAR**                    : name for the variable  
**sg1**                         : name of the 0D-steam generator (SGCARACT)

#### Names of variables which can be read :

These variables are related to the secondary side of the steam generator

PRESSURE	: pressure in the SG (Pa)
LIQMASS	: liquid mass in the SG (kg)
STEAMASS	: steam mass in the SG (kg)
SGPOWER	: exchanged power (W)
SGEXCOEF	: exchange coefficient ( $\text{W}/\text{m}^2/\text{°C}$ )
SGTEMP	: temperature in the SG (°C)
LIQFLOW	: feed-water flow-rate (kg/s)
STMFLOW	: steam flow-rate (kg/s)
VALVFLOW	: safety valve flow-rate (kg/s)
FOULING	: fouling factor
LIQH	: liquid enthalpy (J/kg)
GASHI	: gas enthalpy (J/kg)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 737/851</a>

## 241.22 CCVs calculated in a SGTR

### Syntax

#### For global variables

**x =                    VALUE                    NAMEVAR                    sgtr1;**

#### For partial variables

**x =                    VALUE                    NAMEVAR                    sgtr1                    ip;**

<b>NAMEVAR</b>	: name of the variable (the values are defined on primary side)
<b>sgtr1</b>	: sgtr name
<b>ip</b>	: 1 for sgtr of type “GVFUIT” or “BETHSY” : 1 or 2 for sgtr of type “GVGUIL” ( 1: part of sgtr coming from hot side 2: part of sgtr coming from cold side )

#### Names of the variables which can be read :

### 241.22.1 Global variables

TOTFGLOB	: global sgtr flow rate (kg/s)
LIQFGLOB	: global liquid flow rate (kg/s)
GASFGLOB	: global gas flow rate (kg/s)
TOTHGLOB	: global enthalpy flow (J/s)
LIQHGLOB	: global liquid enthalpy flow (J/s)
GASHGLOB	: global gas enthalpy flow (J/s)
XiFGLOB	: global flowrate of the <i>i<sup>th</sup></i> incondensable (kg/s)
SGTRSTAT	: integer to indicate the SGTR state: ON = 1 – OFF = 0
ICRIT	: flag to indicate if the flow is critical between primary source and secondary sink - ICRIT = 1 the flow is critical - ICRIT = 0 the flow is not critical
TOPEN	: instant when the sgtr has been opened (s)
DTOPEN	: duration for opening the sgtr (s)
SECTMAX	: maximum cross area of the sgtr (m <sup>2</sup> )
SECTBREC	: break opening ratio from SECTMAX (value between 0. and 1.)
NTRUPT	: number of broken tubes corresponding to effective cross section
NODEPRIM	: scalar point of primary axial element where the sgtr is located
NODESEC	: scalar point of secondary axial element where the sgtr is located

### 241.22.2 Partial variables

TOTFLOW	: total sink flow rate (kg/s) on hot or cold side
LIQFLOW	: total liquid flow rate (kg/s) on hot or cold side

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 738/851

GASFLOW	: total gas flow rate (kg/s) on hot or cold side
STMFLOW	: total steam flow rate (kg/s) on hot or cold side
ENTHFLOW	: total enthalpy flow (J/s) on hot or cold side
XiFLOW	: flowrate of the $i^{th}$ incondensable (kg/s) on hot or cold side
LIQFRAi	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the i-th radio-chemical component in liquid phase, on hot or cold side
GASFRAi	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the i-th radio-chemical component in gas phase, on hot or cold side
QTFLOWi	: total flow of the i-th radio-chemical component (GBq/s or kg/s), on hot or cold side
XLFLOWi	: flow of the i-th radio-chemical component in liquid phase (GBq/s or kg/s), on hot or cold side
XGFLOWi	: flow of the i-th radio-chemical component in gas phase (GBq/s or kg/s), on hot or cold side
MASACTi	: cumulated value for QTFLOWi (GBq or kg)

### Example

```
xm1 =          VALUE      ENTHFLOW    sgtr1 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 739/851

## 241.23 CCVs calculated in a turbomachine sub-module (TCOMCHAR)

### Syntax

**xval=**           **VALUE**           **NAMEVAR**       **compi** ;

<b>xval</b>	: value to be read
<b>NAMEVAR</b>	: name of the variable
<b>compi</b>	: name of the TCOMCHAR

#### Names of the variables which can be read :

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 ( $m^5/s^2$ )
TCODENS	: fluid density in the component ( $kg/m^3$ )
TCOTORQ	: total torque ( $m^5/s^2$ )
TCOSPEED	: rotation speed (rad/s)
TCOELEV	: head in component ( $m^2/s^2$ )
MTORQUE	: turbomachine torque (N.m)
INERTIA	: compressor or turbine inertia ( $kg.m^2$ )
NOMV	: nominal rotation speed (rad/s)

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 740/851

<b>NOMFLOW</b>	: nominal volumic flow ( $\text{m}^3/\text{s}$ )
<b>NOMTORQ</b>	: nominal torque ( $\text{m}^5/\text{s}^2$ )
<b>GRAVH</b>	: nominal head ( $\text{m}^2/\text{s}^2$ )
<b>EXPANSIO</b>	: ratio of specific heat ( $C_p/C_v$ )
<b>TDEF</b>	: reference temperature ( $^\circ\text{C}$ )
<b>PITREF</b>	: reference expansion rate for a turbine (adimensional)
<b>ETATREF</b>	: reference isentropic efficiency for a turbine (adimensional)
<b>PICREF</b>	: reference expansion rate for a compressor (adimensional)
<b>ETACREF</b>	: reference isentropic efficiency for a compressor (adimensional)
<b>IMAPALN1</b>	<p>: flag to indicate the location of the turbomachine operating point in the head/compression ratio map with respect to the user specified range of variation of reduced rotating speed.</p> <p>-1 means : reduced rotating speed of operating point is lower than the lowest value given by user (at actual flowrate)</p> <p>0 means : reduced rotating speed of operating point is in the range of values given by user (at actual flowrate)</p> <p>1 means : reduced rotating speed of operating point is greater than the greatest value given by user (at actual flowrate)</p>
<b>IMAPALN2</b>	<p>: flag to indicate the location of the turbomachine operating point in the torque/efficiency map with respect to the user specified range of variation of reduced rotating speed.</p> <p>-1 means : reduced rotating speed of operating point is lower than the lowest value given by user (at actual flowrate)</p> <p>0 means : reduced rotating speed of operating point is in the range of values given by user (at actual flowrate)</p> <p>1 means : reduced rotating speed of operating point is greater than the greatest value given by user (at actual flowrate)</p>
<b>IMAPXNU1</b>	<p>: flag to indicate the location of the turbomachine operating point in the head/compression ratio map with respect to the user specified range of variation of reduced flow rate.</p> <p>-1 means : reduced flowrate of operating point is lower than the lowest value given by user (at actual rotating speed)</p> <p>0 means : reduced flowrate of operating point is in the range of values given by user (at actual rotating speed)</p> <p>1 means : reduced flowrate of operating point is greater than the greatest value given by user (at actual rotating speed)</p>
<b>IMAPXNU2</b>	<p>: flag to indicate the location of the turbomachine operating point in the torque/efficiency map with respect to the user specified range of variation of reduced flowrate.</p> <p>-1 means : reduced flowrate of operating point is lower than the lowest value given by user (at actual rotating speed)</p> <p>0 means : reduced flowrate of operating point is in the range of values given by user (at actual rotating speed)</p> <p>1 means : reduced flowrate of operating point is greater than the greatest value given by user (at actual rotating speed)</p>

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 741/851</a>

## 241.24 CCVs calculated in a TURBINE

### Syntax

**xval =                    VALUE                    NAMEVAR                    turbi ;**

<b>xval</b>	: value to be read
<b>NAMEVAR</b>	: name of the variable
<b>turbi</b>	: name of the TURBINE

#### Names of the variables which can be read :

EFFI	: efficiency of the turbine.
POWER	: imposed power of the turbine. (W)
GAMMA	: value of the $\gamma$ coefficient (= Cp/Cv).

## **241.25 CCVs calculated in a CONTROL VALVE, a CHECK VALVE, a FLOW LIMITER, an ECVALVE or an ECHECK gadget**

## Syntax

x = VALUE NAMEVAR valve;

**xval** : value to be read  
**NAMEVAR** : name of the variable  
**valve** : name of the valve

**Names of the variable which can be read :**

valve type	CCVs
CONTROL VALVE	PU REALPU CV SR KM DELTAP ITCR XFAILURE IFAILURE RO IOBRUN XTVAN
FLOW LIMITER	SR KM DELTAP ITCR RO XTVAN
CHECK VALVE	PU REALPU CV SR KM DELTAP ITCR XFAILURE IFAILURE RO IOBRUN XTVAN
ECVALVE	EQUIVSCT EQUIVKM
ECHECK	EQUIVSCT EQUIVKM

IOBRUN	: flag to indicate if the valve is opened. IOBRUN = 0 the valve is closed IOBRUN = 1 the valve is opened
PU	: position of the control rod (0. means closed, 1. means fully open)
REALPU	: effective position of the control rod (0. means closed, 1. means fully open) taking into account failure
CV	: valve capacity
SR	: reduced flow section ( $m^2$ )
KM	: head loss coefficient <sup>1</sup>
DELTAP	: pressure drop through the valve
ITCR	: flag giving the flow type : ITCR = 0 or 1 sub-sonic condition ITCR = 2 sonic condition with a flow in the direction of the meshing ITCR = 3 sonic condition with a flow in the opposite direction of the meshing
EQUIVSCT	: equivalent SR ( $m^2$ )
EQUIVKM	: equivalent head loss coefficient <sup>1</sup>
XFAILURE	: failure rate (between 0 and 1)
IFailure	: flag to indicate if failure exists (0 for no failure; 1 if it exists)
RO	: specific mass of the fluid under nominal conditions ( $kg/m^3$ ) (imposed by WRITE)
XTVAN	: the default value is 0.1 for CHECK VALVES and 0.6804 ( $= \frac{DP}{P} = 0.84 \cdot C_f^2$ ) for CONTROL VALVES

<sup>1</sup>KM = f(Cv) for control valve and check valve (see fortran subroutine VECKM.f for more information)  
 KM = f(Sr) for flow limiter (see fortran subroutine VECKMFL.f for more information)

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 743/851

<b>Example</b>
----------------

cv1 =                    VALUE                    CV                    vpi1 ;

DE LA RECHERCHE À L'INDUSTRIE 		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 744/851

242

## VALUFEAU DIRECTIVE

The **VALUFEAU** directive provides direct access from the *command block* to the **water and steam properties**. The user provides as input the steam/water state variables ; the directive returns all the corresponding properties (no derivatives) on the basis of predefined symbols, using the reserved OZ prefixe. The available properties and their associated symbols are described hereafter.

This directive is replaced by **VALUEFLD** which is available for all fluids that can be encountered in a circuit.

The syntax of VALUFEAU and VALUEFLD are the same. The corresponding FORTRAN file in the PILOT is also VALUEFLD.f

### Associated Keywords

VALUE, VALUEFLD

243

## **VALVE DIRECTIVE**

The **VALVE** directive is used, in the *command block*, to simulate the closure or aperture of a valve by modifying the singular head losses at a vector point of an axial-type element only. To close a steam line, it is necessary to use a time dependant law.

### **Associated Keywords**

SINGULAR

---

## Syntax

<b>VALVE</b>	elem	ipi	(TVA	timec)	
<b>POSITIVE</b>		xs			
or					
	<b>TIME</b>	<b>REALLIST</b>	x1	...	xn
	<b>COEFF</b>	<b>REALLIST</b>	y1	...	yn
<b>NEGATIVE</b>	xr				
or					
	<b>TIME</b>	<b>REALLIST</b>	x1	...	xn
	<b>COEFF</b>	<b>REALLIST</b>	y1	...	yn
:					

<b>elem</b>	: axial element
<b>ipi</b>	: vector point of the axial element
<b>TVA timec</b>	: OPTIONAL keyword followed by a positive real number giving the absolute time at which the singular head losses are being modified (not used if constant value option is chosen : xs or xr).
<b>POSITIVE NEGATIVE</b>	: keywords introducing values in the same direction as the meshing (POSITIVE) and in the opposite direction (NEGATIVE).
<b>xs or xr</b>	: real numbers defining singular head loss coefficients.
<b>TIME</b>	: relative time regarding TVA
<b>COEFF</b>	: real numbers defining singular head loss coefficients variations as a function of time (relative time).
<b>REALLIST</b>	: keyword followed by a list of real giving the coefficient variations as a function of time (relative time).

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 746/851

**Example**

```

VALVE tuyvapi 30
IF POSITIVE 1.D5 NEGATIVE 1.D5 ;
( xpres < 129.D5
  AND iarurg EQ 0 ) ;
timec = time ;
iarurg = 1 ;
VALVE tuyvapr ip106 TVA timec
POSITIVE TIME REALLIST
0.0 0.5 1.0 1.5
COEFF REALIST
1.D5 1.D8 1.D10 1.D15
NEGATIVE TIME REALIST
0.0 0. 1.0 1.5
COEFF REALIST
1.D5 1.D8 1.D10 1.D12 ;
ENDIF ;

```

**NB :** The corresponding FORTRAN subroutine called in PILOT is VANNE.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 747/851

244

## VECTOR OPERATOR

The **VECTOR operator** is used to get the mesh **number** of the nearest vector point of a given curvilinear coordinate. When the given coordinate is equidistant from two vector points, the result number will correspond to the first of these points in the mesh order. It can be used either in *data block* or *command block*.

**Warning :** A vector point defined in the data block is unknown in the command block. So it has to be defined or redefined in the command block.

### Associated Keywords

SEGMENT, XAXIS, SCALAR

### Syntax

```
ipi =      VECTOR      elem1zj ;
```

**elem1** : axial element name  
**zj** : real number  $\geq 0$ . representing a curvilinear coordinate.

### Example

```
p1 =      XAXIS      0. ;
p2 =      XAXIS      12. ;
t1 =      p1        SEGMENT    6          COS          0.           p2 ;
MESH     elem1      t1 ;
END       DATA ;
INTEGER   ip3        ip4        ip5 ;
ip3 =    VECTOR      elem1      4.5 ;
ip4 =    VECTOR      elem1      7. ;
ip5 =    VECTOR      elem1      9.6 ;
END       EXEC ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 748/851

**N.B.** :The corresponding FORTRAN subroutine called in PILOT is : IVECTO ('ELEMENT1', zj, ivstat)

'ELEMENT1'	Char*8, name of the corresponding element
zj	Real number, curvilinear coordinate of the point
ivstat	Integer, error code (0 if Ok)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 749/851

245

## VERBOSE DIRECTIVE

The **VERBOSE** directive, used in the command block, displays or disables additional printouts during the computation.

### Associated Keywords

OPTION, RESETIME, RESTORE, SAVE, INISIM, MANAGE, FASTSIZE

### Syntax

<b>VERBOSE</b>	<b>object</b>	<b>GENERAL</b>	<b>ival</b> ;
or		<b>PRINBORA</b>	
or		<b>INCIWR</b>	
or		<b>STAT</b>	
or		<b>CONWR</b>	
or		<b>JACOWR</b>	
or		<b>LIST3D</b>	
or		<b>CONSID</b>	

**object** : name of the element for which the printouts are required (REACTOR or AXIAL, or VOLUME or THREED).

**GENERAL ival** : keyword indicating that the general information are required. The element ‘object’ must be a *reactor*. It displays the synchronization between exchangers and for each element of the *reactor* the time step, the convergence index and the number of equations. The keyword is followed by an integer ival :  
 Ival=0 - disables the printouts (default value)  
 Ival=1 - enables the printouts

**PRINBORA ival** : keyword indicating that the radio-chemical fields of the element should not be written to the standard output. The element ‘object’ must be a *reactor*. It can be used to shrink the size of the standard output for computation with many radio-chemical elements. The keyword is followed by an integer ival :  
 Ival=0 - disables the printouts of AXIAL, THREED, VOLUME and TEE components in the REACTOR. CIRCUIT and ZONE will still print balance out.  
 Ival=1 - enables the printouts (default value)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 750/851

- INCIWR ival** : keyword used to enable or disable the messages (in output listing) displayed when variables are out of range. The element ‘object’ must be *an axial, a volume, a threed, a bcondit or a rupture element*.  
The keyword is followed by an integer ival :  
Ival=0 - disables the printouts  
Ival=1 - enables the printouts (default value)
- STAT ival** : keyword used to display the statistics on convergence in V25\_3.CONVR file. The element ‘object’ must be a *reactor*.  
The keyword is followed by an integer ival :  
Ival=0 - disables the printouts (default value)  
Ival=1 - generates the printouts of iterations per elements per time step (cf. OPTION IMPI i <0>)  
Ival=2 - generates V25\_3.train file available for simulator calculation  
This must be specified again after each restoration of calculation.
- CONWR ival** : keyword used to display the fluid state variable increments at each iteration in standard output file. The element ‘object’ must be an *axial, a volume or a threed* element. It displays also the increments for the sub-modules *wall* and *pumpchar*.  
The keyword is followed by an integer ival :  
Ival=0 - disables the printouts (default value)  
Ival=1 - enables the printouts  
Ival=2 - enables the printouts of increments  
If ival is negative, only the increments of the scalar mesh ival and its neighbours will be displayed in order to shrink the printouts (available only for AXIAL or THREED elements).  
N.B : In particular, it gives a list of 0 and 1 values representing convergency (0) or not (1) for increments of principal variables at each iteration ( $P$ ,  $H_L$ ,  $hg$ ,  $\alpha$ , (x1, x2, x3, x4),  $V_L$ ,  $V_G$ ,  $Z_c$ ) in this order).
- JACOWR ival** : keyword used to display some information useful for the control of hydraulic solving.  
The keyword is followed by an integer ival :  
Ival=0 - disables the printouts (default value).  
Ival=1 - displays the Jacobian matrices in JACOB4 file. The element ‘object’ must be an *axial, a volume or a threed* element.  
Ival=2 - displays the comparison of the residual second member with the product (Jacobian)\*(increments) in JACODX file. The element ‘object’ must be an *axial, a volume or a threed* element.  
If ival is negative, only the Jacobian of the scalar mesh ival will be displayed in order to shrink the printouts (available only for AXIAL or THREED elements).
- LIST3D ival** : Controls the orientation of the 3D plane cuts for listing printouts of 3D state variables:  
Ival=1 - use YZ plane  
Ival=2 - use XZ plane
- CONSIS ival** : keyword used to enable or disable the messages (in output listing) displayed in 3D module when there is no consistency (for void fraction, density, enthalpy, energy and non condensable mass fraction variables) between a threed element and an adjacent element.  
Ival=0 - disables the printouts (default value).  
Ival=1 - enables the printouts

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 751/851

246

## VFILM DIRECTIVE

The **VFILM** directive specifies in the *data block* the correlation of heat transfer from walls to fluid that should be used in case of film condensation during containment calculations. The VFILM directive can be defined only in a **VOLUME** element.

**NB:** To activate the calculation with this specific correlation during containment calculations, you must use the directive **STARTVC** in the *command block*. To deactivate the calculation with this specific correlation use the **STOPVC** directive in the *command block*.

<b>Associated Keywords</b>
----------------------------

**STARTVC**, **STOPVC**, **WRITE**, **VOLUME**

<b>Syntax</b>
---------------

<b>VFILM</b>	elem or	<b>NUSSELT</b> <b>NUSSELT</b>	<b>FORCED</b> or or	<b>VCALC</b> <b>VUSER</b> <b>LAW</b>	ival x lawname
	or	<b>USHIDA</b>			
	or	<b>COPAIN</b> or or	<b>VCALC</b> <b>VUSER</b> <b>LAW</b>	ival x lawname	
	or	<b>TAGAMI</b>	<b>ENERGY</b> <b>TP</b>	rval1 rval2 ;	

**elem** : name of the volume element

**NUSSELT** : keyword indicating that the NUSSELT correlation should be used without any other keywords, it means natural convection is assumed. Otherwise, forced convection is assumed. It may then be followed by :

**FORCED** : keyword indicating that the forced convection correlation will be used. It is followed by a keyword indicating which convection velocity will be used :

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 752/851

**VCALC ival**

: keyword indicating that the velocity used in the NUSSELT correlation should be calculated by CATHARE by using a specific formula. The keyword is followed by an integer value ival to specify the number of the formula that should be used for the estimation of convection velocity across the volume :

- ival=1, 2, 3, 4, 5, 6 : various estimations based on the gas velocities at the volume junctions (and taking account the injection sources for ival = 3) and a characteristic length of the volume,
- ival=1 : calculation of a mean gas velocity at all junctions,
- ival=2 : calculation of a mean gas velocity related to the mean hydraulic section,
- ival=3 : calculation of a mean gas velocity for only inlet junctions and related to the mean gas mass flowrate and the mean hydraulic section,
- ival=4 : calculation of a gas velocity based on the maximum velocity calculated for all junctions,
- ival=5 : calculation of a gas velocity based on a CFD code analysis
- ival=6 : the maximum gas velocity for all junctions
- ival > 6 : estimation based on a user's formula (to be modeled in the subroutine VCVMEAN).

or

**VUSER x<sup>1</sup>**

: keyword followed by a positive real number indicating that the velocity used in the NUSSELT correlation should be taken constant and equal to x (m/s).

or

**LAW lawname**

: keyword followed by a law name indicating that the velocity used in the NUSSELT correlation should follows this law.

: keyword indicating that the USHIDA correlation should be used. It assumes natural convection.

**or COPAIN**

: keyword indicating that the COPAIN correlation should be used. It may then be followed by :

: keyword indicating that the velocity used in the COPAIN correlation should be calculated by CATHARE by using a specific formula. The keyword is followed by an integer value ival to specify the number of the formula that should be used for the estimation of convection velocity across the volume :

- ival=1, 2, 3, 4, 5, 6 : various estimations based on the gas velocities at volume junctions (and taking into account the injection sources for ival = 3) and a characteristic length of the volume,
- ival=1 : calculation of a mean gas velocity at all junctions,
- ival=2 : calculation of a mean gas velocity related to the mean hydraulic section,
- ival=3 : calculation of a mean gas velocity for only inlet junctions and related to the mean gas mass flowrate and the mean hydraulic section,
- ival=4 : calculation of a maximum gas velocity based on the maximum velocity calculated for all junction,
- ival=5 : calculation of a gas velocity based on a CFD code analysis
- ival=6 : the maximum gas velocity for all junctions
- ival > 6 : estimation based on a user's formula (to be modeled in the subroutine VCVMEAN).

or

**VUSER x<sup>1</sup>**

: keyword followed by a positive real number indicating that the velocity used in the COPAIN correlation should be taken constant and equal to x (m/s).

or

**LAW lawname**

: keyword followed by a law name indicating that the velocity used in the COPAIN correlation should follows this law (defined in the input deck).

**or TAGAMI**

: keyword indicating that the TAGAMI correlation should be used. It may then be followed by :

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 753/851

- ENERGY rval1** : keyword followed by a real value rval1 to specify the value of the energy (J) used in the TAGAMI correlation
- TP rval2** : keyword followed by a real value rval2 to specify the value of the TP time (s)

---

<sup>1</sup>The given x value can be changed by CCV (refer to WRITE directive for a volume element- VGMEAN keyword).

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 754/851

247

## VOLUME OPERATOR

The **VOLUME** operator, in the *data block*, creates a VOLUME element by defining its topology.

### Associated Keywords

**GEOM, FLOMIXER, LEVEL, SINGULAR, SINGUMOD, VFILM, CCFL, VALBA FOR VOLUME, VALUE FOR VOLUME, WRITE FOR VOLUME**

### Syntax

```
elem =      VOLUME
           junc1      sens1
           ...
           juncn      sensn
           (WEIGHT    ip)
           (PRSRIZER)
           (PWRPRZ)
           (PWRACC)
           (POOLEVAP)
           (QLEFR62) ;
```

**elem** : volume element

**junci sensi** : junction element followed by a keyword defining the orientation of the junction in the element. This keyword is USTREAM or DSTREAM<sup>1</sup>. || **To be repeated for each junction.**

**WEIGHT ip** : OPTIONAL keyword followed by a positive integer defining the weight of the element. The default value for the weight is 1.  
**Definition:** The weight of an element is the number of identical real elements it is simulating. The weight of elements is required for mass and energy balances.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 755/851</a>

- PRSRIZER** : OPTIONAL keyword used to increase the heat transfer between upper and lower sub-volumes in the pressurizer element during steady-state calculation, in order to reduce the time constants associated with pressurizer dynamics.
- PWRPRZ** : OPTIONAL keyword used to modify pressurizer behaviour (normal and auxiliary spray, charging and let down mode, and heaters behaviour) in case of power plant initialization.
- PWRACC** : OPTIONAL keyword used to accumulator type heat transfer behaviour (no steam in upper sub volume, wall heat exchanges with nitrogen, natural convection on free surface).
- POOLEVAP** : OPTIONAL keyword used to modify heat transfer between upper and lower subvolumes during a transient calculation in case of a RJH application.
- QLEFR62** : OPTIONAL keyword used to modify for the flashing term of the interface to liquid heat flux only on this volume.

<b>Example</b>
----------------

```

pressu =      VOLUME      expresur      USTREAM      PRSRIZER      ;
cavitei =     VOLUME      entsechi     USTREAM
              sortdci      DSTREAM
              sortvapi     DSTREAM
WEIGHT 2 ;

```

---

<sup>1</sup>the choice is insignificant, provided you have controlled that for the other element related to this junction, the other keyword is used.

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 756/851

248

## WALL3D OPERATOR

Used in the data block, the **WALL3D** operator enables to define and activate the wall element for a THREED element. The order of the keywords indicated below must be respected.

**Remarks :**

1. **The materials defined by the user:** In CATHARE 2, there are 6 + 50 user defined materials that must be defined in a special subroutine FWMAXX or FWMAYY respectively, with material index (INDMAT) given as argument. The name of the first group of 6 user defined materials must begin with 'XXXXXXXX' and the last character is an integer between 1 and 6 ie : XXXXXXXX1 (INDMAT=28) to XXXXXXXX6 (INDMAT=33) (see FWMAXX subroutine).  
The name of the second group of 50 user defined materials must begin with 'YYYYYYY' and the two last characters are integers between 01 and 50 ie : YYYYYY01 (INDMAT=38) to YYYYYY50 (INDMAT=87) (see FWMAYY subroutine).
2. 10 other materials can be defined in the data block using **MATERIAL** operator. The properties of these materials are defined as polynomial functions of the wall temperature in a given range of temperature.

**Associated Keywords**

**WALL, FLUMOD, ADIABWAL, POWER, PNRSHAPE, PNRSHAPX, WRITE FOR 3D WALL, VALUE FOR 3D WALL**

**Syntax**

**Warning :** DIAM, DINI, DEND keywords are relating to CYLINDER walls, THICK, THINI, THEND are relating to PLANE walls

p1 =	<b>WALL3D</b>	elem	<b>INTERNAL</b>		<b>(PLANE)</b>		
			(CYLINDER) or (WREFLINK wallref)				
		or	(WREFLINK NOREFLAW)				
			(RADIATW) (AXICOND) (MATERIAL)				
			material1				
			<b>DATA</b>	nm1	<b>DIAM</b>	(or)	<b>THICK</b>

			d1	d2...	dnm1+1
or					
<b>DATA</b>	nm1	<b>DINI</b> d11 <b>DEND</b> d12	(or d21... (or d22... or Ø	<b>THINI)</b> dnm11+1 <b>THEND)</b> dnm12+1	
<b>SEGMENT</b>	X begpt begpt <b>HSURF</b>	or Y endpt endpt hsurf	or Z		
			or	realist_hsurf	
<b>(SOURCE</b>	<b>MEDIUM</b> <b>VOLPOWER</b>	medium volp	<b>LAW</b> or	law1 realist_volp	
<b>(SOURCE ...)</b>					
<b>(LOSS</b>	<b>(RADEXT</b> <b>EEXT</b> <b>(TEXT</b>	eext1	or	liste1 listt1 )	
and/or	<b>HEXT</b>	text1	or		
or	<b>TEXT</b> <b>PHIEXT</b> <sup>1</sup>	hext text phiext			
<b>DATA</b>					
pt1	<b>HSURF</b>	<b>(LOSS</b>	...	<b>(SOURCE...</b>	)
...					
ptn	<b>HSURF</b>	<b>(LOSS</b>	...	<b>(SOURCE...</b>	)
;					

<b>elem</b>	: three element
<b>INTERNAL</b>	: keyword indicating that the wall is internal with respect to the fluid flow. In cases where the wall is external with respect to the flow, <b>INTERNAL</b> will be replaced by the keyword <b>EXTERNAL</b> .
<b>PLANE</b>	: OPTIONAL keyword indicating that the wall is a plane wall ( by default, walls are <b>CYLINDER</b> ). Then you should use keywords <b>THICK</b> instead of <b>DIAM</b> , <b>THINI</b> instead of <b>DINI</b> and <b>THEND</b> instead of <b>DEND</b> .
<b>WREFLINK</b>	: OPTIONAL keyword defining the reference reflooded wall. This keyword allows the wall p1 to use the same physical correlation (specific in case of reflooding, i.e. to calculate the wall-fluid heat exchanges) as the wall wallref. The keyword is followed by :

`^1phiext1 > 0` means heat given to the wall

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 758/851

<b>wallref</b>	: name of the reference reflooded WALL3D element. The reflooding characteristics must have already been defined for this wall (by REFLCH3D). But none reflooding characteristics must be defined for wall p1.
<b>NOREFLAW</b>	: keyword indicating that the wall p1 uses the standard physical laws.
<b>RADIATW</b>	: OPTIONAL keyword indicating that the radiation heat transfer over 5 bars will be limited to its value for 5 bars.
<b>AXICOND</b>	: OPTIONAL keyword which indicates that axial conduction within the wall will be computed. To enable axial conduction, AXICOND directive has to be declared in the command block.

The description of the material, the geometry ... for the wall follows:

<b>material1</b>	: imposed keyword defining the nature of the material used, to select from the following list :	<b>To be repeated as many times as number of materials</b>
MGO	Magnesium oxide	
TOPHET <sup>1</sup>	Tophet A (Nichrome 5)	
NITRBORE	Boron nitride	
ACIER533	Steel SA533 grade B	
ACIER508	A508 carbon steel	
INOXVES <sup>2</sup>	Stainless steel	
INOX304	304 stainless steel	
INOX316	316 stainless steel	
INOX347	347 stainless steel	
INCON600	Inconel 600	
INCON690	Inconel 690	
INCON718	Inconel 718	
INCON800	Inconel 800	
INCON625	Inconel 625	
LOB14948	1.4948 (Lobi Loop)	
CERAMIC	Ceramic (Al <sub>2</sub> O <sub>3</sub> )	
NI201	Ni 201	
LOB14571	1.4571 (Lobi Loop)	
GAP	100% Helium	
ZIRCALOY	zircaloy	
AL2O3	Al <sub>2</sub> O <sub>3</sub> (Alumin for REBEKA)	
XXXXXXi	(i=1,6) user defined material name (FWMAXX subroutine to be defined in the range 28 to 33 )	
YYYYYYij	(i=1,50) Name given to a material defined with the MATERIAL operator	

**NB:** Materials will be given in increasing order of diameters.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 759/851

### \*Radial mesh

The radial mesh data (m) will be given in increasing order.

⇒ Two possibilities to enter the radial mesh of the wall

#### 1) DATA nm1

: keyword indicating that the radial mesh will be defined mesh by mesh by the user. This is followed by an integer  $> 0$  defining the number of meshes in the thickness of the wall. **nm1 must be the same for all segments of the wall.**

Two possibilities:

The diameters or thicknesses are constant along the segment:

#### DIAM d1 d2

...

#### dnm1+ 1

(case of cylinder wall)

: keyword indicating that the diameters are constant all along the segment. This is followed by  $nm1+1$  real numbers  $> 0$ . defining the diameters of each radial mesh.

or

#### THICK d1 d2

...

#### dnm1+ 1

(case of plane wall)

: keyword indicating that the thicknesses are constant all along the segment. This is followed by  $nm1+1$  real numbers  $> 0$ . defining the thickness of each radial mesh:

The first value (d1) has no real meaning , it is a reference value;  
 $d2 = d1 + \text{thickness\_radial\_mesh\_cell1}$ , etc...

or

The diameters or thicknesses vary linearly along the segment.  
 The diameters or thicknesses at the start and at the end of the segment are then given. Diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by linear interpolation between the values given at the start and end of the segment.

#### DINI d11 d21

...

#### dnm11+1

or

#### THINI d11 d21

...

#### dnm11+1 (case of a PLANE wall)

: keyword followed by  $nm1+1$  real numbers  $> 0$ . defining diameters at the start of the segment.

: keyword followed by  $nm1+1$  real numbers  $> 0$ . defining thicknesses at the start of the segment.

The first value (d11) has no real meaning ;  
 $d21 = d11 + \text{thickness\_radial\_mesh\_cell1}$ , etc...

#### DEND d12 d22

...

#### dnm12+1

or

**To be  
repeated as  
many times  
as number of  
matériaux**

<sup>1</sup>Beware that **CATHARE**  $\rho \times Cp$  values for TOPHET have been found to be strongly underestimated

<sup>2</sup>Beware that **CATHARE**  $\rho \times Cp$  values for INOXVES have been found to be false ( $< 0$ ) above 890 °C

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 760/851

<b>THEND d12 d22</b> ... <b>dnm12+1 (case of a PLANE wall)</b>	: keyword followed by nm1+1 real numbers > 0. defining thicknesses at the end of the segment. The first value (d12) has no real meaning ; d22 = d12 + thickness_radial_mesh_cell1, etc...
<b>Warning :</b> In the present version, nm1 must be the same for all the segments of a single wall.	

#### **\* Definition by segment**

<b>SEGMENT</b> <b>begpt</b> <b>endpt</b>	: keyword to indicate that all the mesh cell numbers from begpt to endpt are concerned by the specification. <b>X or Y or Z when nothing is input, Z is the default value</b> direction used to describe the segment included between <i>begpt</i> and <i>endpt</i> : X i.e. X direction, Y i.e. Y direction, Z i.e. direction Z , Ø the default value is used i.e. Z direction. For further information about THREEED numbering, please refer to User Manuel.  : first mesh cell number to be considered (with respect to the absolute scalar numbering). : last mesh cell number to be considered (with respect to the absolute scalar numbering). Then all the mesh cell numbers, within a step depending on the direction, between <i>begpt</i> and <i>endpt</i> are taken into account.	<b>To be repeated as many times as number of segments</b>
--	--	---

#### **\* Heating surface**

<b>HSURF</b> <b>hsurf</b> <b>or realist_hsurf</b>	: keyword followed by : : a real number defining the exchange area by mesh [m <sup>2</sup> ] between the wall and the fluid. : a realist object defining the exchange area for each mesh of the segment.
---	--

#### **\* Case of an exchange with the outside environment**

<b>LOSS</b> <b>RADEXT</b>	: OPTIONAL keyword indicating that an exchange between the wall and the outside will be defined.  : OPTIONAL keyword, informing the system that radiative exchange exists with the outside. By default there is no radiative exchange.  Three possibilities to enter the exchange with outside environment :  <b>Warning :</b> Radiative exchange ( <b>case a</b> ) may be combined with the convective exchange ( <b>case b or c</b> )
<b>a) Case where the exchange is defined by a non-dimensional surface emissivity and an outside temperature</b>	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 761/851

<b>EEXT ext</b>	: keyword indicating that the non-dimensional surface emissivity used for radiation heat transfer is going to be defined. It is followed by a real number $\geq 0$ . and $\leq 1$ . defining the non-dimensional surface emissivity used for radiation heat transfer.
<b>TEXT text</b>	: keyword indicating that the outside temperature is going to be defined. It is followed by a real number $> -273$ . $^{\circ}\text{C}$ defining the outside temperature [ $^{\circ}\text{C}$ ].  <b>b)</b> Case where the exchange is expressed by means of <b>a convective exchange coefficient and an outside temperature</b>
<b>HEXT hext</b>	: keyword indicating that the convective exchange coefficient is going to be defined. It is followed by a real number $> 0$ . defining the convective exchange coefficient [ $\text{W}/\text{m}^2/\text{C}$ ].
<b>TEXT text</b>	: keyword indicating that the outside temperature is going to be defined. It is followed by a real number $> -273$ . $^{\circ}\text{C}$ defining the outside temperature [ $^{\circ}\text{C}$ ].  <b>c)</b> Case where the exchange coefficient is expressed by means of <b>an exchange flux with the outside environment</b>
<b>PHIEXT phiext</b>	: keyword indicating that the exchange flux is going to be defined. It is followed by a real number defining the exchange flux [ $\text{W}/\text{m}^2$ ]. The flux is lost by the wall if ( $\phi_{ext} < 0$ ) and received if ( $\phi_{ext} > 0$ ).

#### \* Case of an heat source

<b>SOURCE</b>	: OPTIONAL keyword indicating that a source exists in the wall. By default there is no source. This keyword is followed by :
<b>MEDIUM med</b>	: keyword followed by an integer $> 0$ , defining the index of the heating material.
<b>LAW law</b>	: keyword followed by a law element defining the power multiplication factor variation law as a function of time. (law 'TIME' 'POWER').
<b>VOLPOWER</b> <b>volp</b> <b>or</b> <b>realist_volp</b>	: keyword indicating that the volumetric power is to be given : real number defining the volumetric power per mesh [ $\text{W}/\text{m}^3$ ]. (if the volumetric power is given on each of the axial meshes of the segment) : : realist object (see REALIST directive) defining the value of the volumetric power [ $\text{W}/\text{m}^3$ ] on each of the axial meshes of the segment. <b>NB</b> : Several materials in a wall can receive internal heat power if the law is the same for all.

**Warning** : In the present version, only one law can be used for a given wall.

To be  
repeated as  
many times  
as number of  
segments

#### \* Definition by mesh

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 762/851</a>

**DATA**

: keyword to indicate that certain meshes are concerned by the specification. For each point pt1 ... ptn exchange area has to be defined and also, if needed, the exchange with the outside and/or source term.

**pt1**
**HSURF hsurf**

: integer specifying the number of the mesh followed by a keyword HSURF indicating that the exchange area between the wall and the outside is going to be defined. It is followed by a real number  $> 0$  defining the exchange area [ $\text{m}^2$ ] for the mesh pt1. The weight of the fuel rods (see FUELCHAR OPERATOR) is important in the calculation of the exchange area.

**LOSS**

: OPTIONAL keyword indicating that an exchange between the wall and the outside will be defined for this point.

**RADEXT**

: OPTIONAL keyword, informing the system that a radiative exchange exists with the outside. By default there is no radiative exchange.

Three possibilities to enter the exchange with the outside environment:

**a) Case where the exchange is defined by a non-dimensional surface emissivity and an outside temperature**

**EEXT eext**

: keyword indicating that the non-dimensional surface emissivity used for radiation heat transfer is going to be defined. It is followed by a real number  $\geq 0$ . and  $\leq 1$ . defining the non-dimensional surface emissivity used for radiation heat transfer.

**TEXT text**

: keyword indicating that the outside temperature is going to be defined. It is followed by a real number  $> -273$  °C defining the outside temperature [°C].

**b) Case where the exchange is expressed by means of a convective exchange coefficient and an outside temperature**

**HEXT hext**

: keyword indicating that the convective exchange coefficient is going to be defined. It is followed by a real number  $> 0$ . defining the convective exchange coefficient [ $\text{W}/\text{m}^2 / \text{°C}$ ]

**TEXT text**

: keyword indicating that the outside temperature is going to be defined. It is followed by a real number  $> -273$  °C defining the outside temperature [°C]

**c) Case where the exchange coefficient is expressed by means of an exchange flux with the outside environment**

**PHIEXT phiext**

: keyword indicating that the exchange flux is going to be defined. It is followed by a real number defining the exchange flux ( $\text{W}/\text{m}^2$ ). The flux is lost by the wall if ( $\phi_{ext} < 0$ ) and received if ( $\phi_{ext} > 0$ ).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 763/851

Example
---------

```

rlhs =      REALLIST   1.875    0.923    0.923    0.923
            0.923    1.846    0.923    0.923
            0.923    0.923    1.875    ;
rlvp =      REALIST    13D8     . 17D8    . 24D8    . 31D8
            . 37D8    . 40D8    . 37D8    . 31D8
            . 24D8    . 13D8    . 13D8    ;
colda1 =    WALL3D    canal    INTERNAL CYLINDER
            MATERIAL  NITRBORE
            DATA      1          DIAM      0.           3.6D-3
            TOPHET   DATA      1
            DIAM     3.6D-3  5.D-3
            NITRBORE DATA      2
            DIAM     5.D-3   6.9D-3  8.3D-3
            INCON800 DATA      2
            DIAM     8.3D-3  8.9D-3  9.5D-3
            SEGMENT   1          11
            HSURF    rlhs
            SOURCE   MEDIUM   2          LAW        lawcolda
            VOLPOWER
            rlpv ;

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 764/851

249

## WALLCOM OPERATOR

The **WALLCOM** operator, used in *data block*, creates a wall object for cryogenic **COMETE** applications. ,

This wall can be associated only to an axial element.

This wall is created to allow flux and temperatures coupling with a 3D thermal code. So it is defined without radial mesh and material and the conduction model is not used.

A wall element created with WALLCOM operator is defined on segments delimited by 2 vector points which must belong to the axial element. A mesh can appear only once in the wall element. The wall element contains all **the segments** that are declared together in the wall definition.

**Warnings :**

1. Only one wall can be associated to an axial element when it is created with WALLCOM operator.
2. The wall must be defined on the whole axial length.

**Associated Keywords**

**WALLMOD**, **AXIAL**, **COMETE**

**Syntax**

<b>P =</b>	<b>WALLCOM</b>	<b>elemnam</b>				
		( <b>NATCONV</b> )	( <b>FILM</b> )	( <b>NONETABL</b> )	<b>POSITIVE</b>	
					or	
					<b>NEGATIVE</b> )	
		<b>SEGMENT</b>	<b>Pi</b>	<b>Pj</b>		
		<b>WNUM</b>	<b>Nwi</b>	( <b>WGROU</b>		
		( <b>HPERIM</b>	<b>CONST</b>	<b>peri</b>	)	
		( <b>MULTH</b>	<b>xhint</b>	<b>xhext</b>		
		<b>(SEGMENT</b>	<b>Pj</b>	<b>Pk</b>		
			<b>...</b>		)	
						;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 765/851

<b>elemnam</b>	: name of the axial element.	
<b>NATCONV</b>	: OPTIONAL keyword indicating that the wall to fluid natural convection will be taken into account (ON) or not (OFF) in the calculation of the heat transfer coefficients. By default the option is OFF.	
<b>FILM</b>	: OPTIONAL keyword indicating that the wall to fluid film heat transfer coefficients will be calculated (ON) or not (OFF). By default the option is OFF	
<b>NONETABL</b>	: OPTIONAL keyword indicating that the geometric factor due to transient operating conditions will be taken into account (ON) or not (OFF) in the calculation of the wall to fluid heat transfer coefficient. When taken into account, precise if the fluid flows in direction (POSITIVE) or in the reverse direction (NEGATIVE) according to the meshing orientation. By default, the option is OFF.	
<b>SEGMENT</b>	: keyword indicating that a segment is to be read and upon which a wall is to be defined. This is followed by :	
<b>Pi Pj</b>	: vector points which must belong to the mesh of the axial element and which defines the start and the end of the segment.	<b>To be repeated as many times as number of segments</b>
<b>WNUM nwi</b>	: keyword followed by an integer nwi > 0 indicating the number of elementary walls on each hydraulic mesh of the segment.	
<b>WGROUPE ngri</b>	: OPTIONAL keyword followed by an integer ngri > 0 indicating the maximal number of elementary walls on each hydraulic mesh of the segment. If nwi > ngri , the elementary walls must be gathered to impose ngri elementary walls on each hydraulic mesh. Default value of ngri is 12.	
<b>HPERIM</b>	: OPTIONAL keyword indicating that the heating perimeter is to be given. This is followed by :	
<b>CONST peri</b>	: keyword indicating that the heating perimeter is constant all along the segment. This is followed by a real number peri > 0 defining the heating perimeter (m).	
<b>MULTH</b>	: OPTIONAL keyword used to modify the standard heat exchange correlation. This is to account for heat exchange devices such as fins ; such devices cannot be properly simulated by a modification of the heating perimeter. This keyword is followed by :	
<b>xhint</b>	: value of the multiplicative coefficient for the inner side of the wall	
<b>xhext</b>	: value of the multiplicative coefficient for the outside of the wall	

### Example

```

Branche1 = AXIAL... ;
PB01 = XAXIS 0.0 ;
PB02 = XAXIS ...;
...
PB15 = XAXIS ...;

```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 766/851

...

```

Par1 =
WALLCOM      Branche1
NATCONV
SEGMENT      PB01          PB08
WNUM         10
HPERIM        CONST         1.5D-1       MULTH      1.D0      3.5D0
SEGMENT      PB08         PB15
WNUM         6            WGROUP      20
...
```

END DATA ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 767/851

250

## WALL GROUP OPERATOR

The **WALL GROUP** operator creates a WALL of type **GROUP** in the *data block*. This operator must be coupled to an **AXIAL GROUP** element. It links a wall to each axial element of the group. This wall is copied from a model already defined in the data block

### Associated Keywords

JUNCTION GROUP, AXIAL GROUP, WALL GROUP, FUELCHAR GROUP, BCONDIT GROUP, ZONE, CIRCUIT, PERMIT, REALC

### Syntax

```
wana1 =      WALL      GROUP      axna      TEMPLATE      wana2 ;
```

wana1	: Name of an <b>WALL GROUP</b> object. It must not exceed 5 characters
axna	: Name of an <b>AXIAL GROUP</b> element
<b>TEMPLATE wana2</b>	: Keyword followed by the name of a wall defined in the data block. This operator will duplicate the characteristics of the wana2 wall for each axial element contained in the <b>AXIAL GROUP</b> object.

### Example

The axial “meancore” and its wall “carcb” must be defined first:

carcb =	WALL	meancore	INTERNAL	SEGMENT	P8	P11
mgo		ISO	1	DIAM	0.	1.d-3
tophet		ISO	1	DIAM	1.d-3	2.4d-3
mgo		ISO	1	DIAM	2.4d-3	8.36d-3
RESIST	VALUE	1.0D+2	RIGHT			
incon800		ISO	2	DIAM	8.36d-3	9.5d-3
HPERIM		CONST	2.9845d-2			
SOURCE		MEDIUM	2 LAW	law1		
VOLPOWER		listpow	;			

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 768/851

```
bota=      JUNCTION   GROUP      157
          SUFFIX       1
          WEIGHT      CONST      264 ;
topa=      JUNCTION   GROUP      157
          SUFFIX       1
          WEIGHT      CONST      264 ;
```

```
cana =      AXIAL      GROUP
          TEMPLATE   meancore
bota        USTREAM    topa        DSTREAM    ;
```

Then the **WALL GROUP** wcana can be defined: wcana will contain 157 identical wall called wcana001 to wcana157. These walls will be linked to the axial elements cana001 to cana157.

```
wcana =      WALL      GROUP      cana      TEMPLATE      carcb ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 769/851

251

## WALLMOD DIRECTIVE

The **WALLMOD** directive is used in *command block* to change the calculation options for the heat transfer coefficients (film, natural convection, transient operating conditions) between the walls and the 1D axial elements.

### Associated Keywords

**WALL**, **WALLCOM**, **AXIAL**, **COMETE**

### Syntax

```

WALLMOD elemnam FILM ON / OFF ;
or NATCONV ON / OFF ;
or NONETABL ON POSITIVE ;
or NEGATIVE ;
or OFF ;
;
```

**elemnam** : name of the element (circuit, axial element or wall associated to an axial element).  
If the element is a circuit, all the walls associated with axial elements of the circuit are modified.  
If the element is an axial element, all the walls associated with this axial element are modified.

**FILM** : keyword to indicate that the film heat transfer coefficients will be calculated (ON) or not (OFF).  
By default the option is OFF.

**NATCONV** : keyword to indicate that the natural convection will be taken into account (ON) or not (OFF) in the calculation of the heat transfer coefficients.  
By default the option is OFF.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 770/851

**NONETABL** : keyword to indicate that the geometric factor due to transient operating conditions will be taken into account (ON) or not (OFF) in the calculation of the heat transfer coefficient.  
When taken into account, precise if the fluid flows in direction (POSITIVE) or in the reverse direction (NEGATIVE) according to the meshing orientation.  
By default, the option is OFF.  
**Warning :** this option can be activated only if the wall is defined at the first mesh of the pipe.

<b>Example</b>
----------------

```

WALLMOD Paroi1      FILM        OFF       ;  

...  

WALLMOD CIRCP      NATCONV    ON        ;  

...  

WALLMOD Paroi2      NONETABL   ON        POSITIVE  ;

```

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 771/851

252

## WALL OPERATOR

The **WALL** operator creates, in the *data block*, a wall object by defining its characteristics.

The input data is specific to the type of hydraulic element AXIAL or VOLUME.

### **REMARKS :**

1. A wall cannot be defined for BCONDIT elements.
2. **The materials defined by the user:** In CATHARE 2, there are 6 + 50 user defined materials that must be defined in a special subroutine FWMAXX or FWMAYY respectively, with material index (INDMAT) given as argument. The name of the first group of 6 user defined materials must begin with 'XXXXXXXX' and the last character is an integer between 1 and 6 ie : XXXXXXX1 (INDMAT=28) to XXXXXXX6 (INDMAT=33) (see FWMAXX subroutine).  
The name of the second group of 50 user defined materials must begin with 'YYYYYY' and the two last characters are integers between 01 and 50 ie : YYYYYY01 (INDMAT=38) to YYYYYY50 (INDMAT=87) (see FWMAYY subroutine).
3. 10 other materials can be defined in the data block using **MATERIAL** operator. The properties of these materials are defined as polynomial functions of the wall temperature in a given range of temperature.

### Associated Keywords

**WALL3D, FLUMOD, WALLMOD, ADIABWAL, POWER, RADIAT, PNRSHAPE, PNRSHAPX, COMPONEN, EXWALINK, MATERIAL, RJH, VALUE FOR WALL, WRITE FOR WALL**

## 252.1 WALL on a 1-D element

For an axial element a wall element is defined on segments delimited by 2 vector points which must belong to the axial element. A mesh can appear only once in a wall element. For each segment, a heat **SOURCE** term and a heat **LOSS** term can be defined. The wall element contains all **the segments** that are declared together in the wall definition.

### Syntax

**Warning :** DIAM, DINI, DEND keywords are relating to CYLINDER walls, THICK, THINI, THEND are relating to PLANE walls



<b>p1 =</b>	<b>WALL</b>	<b>elem</b>	<b>INTERNAL (CYLINDER)</b>	<b>or</b>	<b>EXTERNAL (PLANE)</b>
			<b>(WREFLINK</b>	<b>or</b>	<b>wallref)</b>
			<b>(WREFLINK</b>	<b>NOREFLAW)</b>	
	<b>(RADIATW)</b>				
	<b>(RJHCHANL)</b>	<b>or</b>	<b>PNCHANL)</b>		
	<b>(AXICOND)</b>				
	<b>(FILM)</b>				
	<b>(NATCONV)</b>				
	<b>(NONETABL</b>	<b>POSITIVE</b>			
		<b>or</b>			
		<b>NEGATIVE)</b>			
<b>SEGMENT</b>	<b>Pi</b>	<b>Pj</b>			
	<b>material1</b>				
	<b>DATA</b>	<b>nm1</b>	<b>DIAM</b>	<b>(or</b>	<b>THICK)</b>
			<b>d1</b>	<b>d2...</b>	<b>dnm1+1</b>
	<b>or</b>				
	<b>DATA</b>	<b>nm1</b>	<b>DINI</b>	<b>(or</b>	<b>THINI)</b>
			<b>d11</b>	<b>d21...</b>	<b>dnm11+1</b>
			<b>DEND</b>	<b>(or</b>	<b>THEND)</b>
			<b>d12</b>	<b>d22...</b>	<b>dnm12+1</b>
	<b>or</b>				
	<b>ISO</b>	<b>nm1</b>	<b>DIAM</b>	<b>(or THICK)</b>	
			<b>di</b>	<b>dext</b>	
	<b>or</b>				
	<b>ISO</b>	<b>nm1</b>	<b>DINI</b>	<b>(or THINI)</b>	
			<b>di1</b>	<b>dext1</b>	
			<b>DEND</b>	<b>(or THEND)</b>	
			<b>di2</b>	<b>dext2</b>	
	<b>(RESIST</b>	<b>VALUE</b>	<b>hres</b>	<b>RIGHT</b>	
			<b>or</b>	<b>LEFT</b>	
	<b>or</b>	<b>MODEL</b>	<b>YYYYYYij</b>	<b>(HEATFLUX</b>	<b>RIGHT</b>
				<b>or TEMP )</b>	<b>or LEFT)</b>
			<b>(material2)</b>		
		<b>...</b>			
<b>HPERIM</b>	<b>POINT</b>	<b>ip1</b>	<b>peri1</b>		
		<b>ip2</b>	<b>peri2</b>		
		<b>(ip3</b>	<b>AND</b>	<b>ip4)</b>	<b>peri3</b>
		<b>...</b>			
	<b>or</b>				
	<b>CONST</b>	<b>peri</b>			
	<b>( MULTH</b>	<b>xhint</b>	<b>xhext )</b>		
<b>(SOURCE</b>	<b>MEDIUM</b>	<b>miq1</b>	<b>LAW</b>	<b>law1</b>	
	<b>VOLPOWER</b>	<b>puis1</b>	<b>or</b>	<b>list1</b>	
	<b>or</b>				
	<b>PINI</b>	<b>puisini</b>			
	<b>PEND</b>	<b>puisfin</b>			
				<b>)</b>	
	<b>(SOURCE ...)</b>				

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 773/851

<b>(LOSS</b>	<b>(RADEXT</b> <b>EEXT</b> eext1 or liste1      CASE A <b>(TEXT</b> text1 or listt1 ) or <b>EINI</b> eexini <b>EEND</b> eexfin <b>TINI</b> texini <b>TEND</b> texfin			
and/or	<b>HEXT</b> hext1 or listh1      CASE B <b>TEXT</b> text1 or listt1 or <b>HINI</b> hexini <b>HEND</b> hexfin <b>TINI</b> texini <b>TEND</b> texfin			
or	<b>PHIEXT</b> <sup>1</sup> phiext1 or list1      CASE C or <b>PHINI</b> phiini <b>PHIFIN</b> phifin )			
<b>(POINTSG</b>	<b>HEXT</b> hext1 or listh1 <b>HINI</b> hexini <b>HEND</b> hexfin )			
<b>(SEGMENT</b>	<b>Pk</b> Pl ... ; ;			

<b>elem</b>	: axial element
<b>INTERNAL</b>	: keyword indicating that the wall is internal with respect to the flow. In cases where the wall is external with respect to the flow, INTERNAL will be replaced by the keyword EXTERNAL.
<b>PLANE</b>	: OPTIONAL keyword indicating that the wall is a plane wall. CYLINDER is the default option. Then you should use keywords THICK instead of DIAM, THINI instead of DINI and THEND instead of DEND to define thickness of plane walls.
<b>NOREFLAW</b>	: OPTIONAL keyword (default value) indicating that the wall p1 uses the standard physical laws.
<b>WREFLINK</b>	: OPTIONAL keyword defining the reference reflooded wall. ( <b>NOREFLAW</b> is the default option). This keyword allows the wall p1 to use the same physical correlations (specific in case of reflooding, i.e. to calculate the wall-fluid heat exchanges) as the wall wallref. The keyword is followed by :
<b>wallref</b>	: name of the reference reflooded WALL element. The reflooding characteristics must have already been defined for this wall (by REFLCHAR). But no reflooding characteristics must be defined for wall p1.

<sup>1</sup>phiext1 > 0 means heat given to the wall

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 774/851

Three cases are possible depending on the relative position between p1 and wallref :

- partial overlapping WREFLINK wallref (MANDATORY)
- complete overlapping WREFLINK wallref (by default)
- no overlapping NOREFLAW (by default)

<b>RADIATW</b>	<p>: OPTIONAL keyword indicating that the radiation heat transfer over 5 bars will be limited to its value for 5 bars.</p>
<b>RJHCHANL or PNCHANL</b>	<p>: OPTIONAL keyword to indicate that the user applies to this wall the physical closure relationships of the <b>RJH</b> or of the <b>NP</b>.</p> <p>Remark: To use this model, the user must verify that:            He had activated the same keyword in the associated axial hydraulic element,            If this <b>RJH/NP</b> wall is not as long as the associated hydraulic element, he had to define other <b>RJH/NP</b> wall(s) to complete the empty area,            There is one and only one <b>RJH/NP</b> wall mesh for each hydraulic mesh.</p>
<b>AXICOND</b>	<p>: OPTIONAL keyword which indicates that axial conduction within the wall will be computed.</p> <p>To enable axial conduction, AXICOND directive has to be declared in the command block.</p>
<b>FILM</b>	<p>: OPTIONAL keyword to indicate that the wall to fluid film heat transfer will be calculated (ON) or not (OFF).</p> <p>By default the option is OFF</p>
<b>NATCONV</b>	<p>: OPTIONAL keyword to indicate that the natural convection will be taken into account (ON) or not (OFF) in the calculation of the heat transfer coefficients.</p> <p>By default the option is OFF.</p>
<b>NONETABLI</b>	<p>: OPTIONAL keyword to indicate that the geometric factor due to transient operating conditions will be taken into account (ON) or not (OFF) in the calculation of the heat transfer coefficient. When taken into account, precise if the fluid flows in direction (POSITIVE) or in the reverse direction (NEGATIVE) according to the meshing orientation.</p> <p>By default, the option is OFF.</p> <p><b>Warning</b> : this option can be activated only if the wall is defined at the first mesh of the pipe.</p>

<b>SEGMENT</b>	<p>: keyword indicating that a segment is to be read and upon which a wall is to be defined. This is followed by :</p>
<b>Pi Pj</b>	<p>: vector points which must belong to the mesh of the axial element and which defines the start and the end of the segment.</p>
<b>Material1</b>	<p>: imposed keyword defining the nature of the material used, to select from the following list</p>

**To be  
repeated as  
many times  
as number of  
segments**

<b>material1</b>	<p>: imposed keyword defining the nature of the material used, to select from the following list :</p>
<b>MGO</b>	<p>Magnesium oxide</p>
<b>TOPHET<sup>1</sup></b>	<p>Tophet A (Nichrome 5)</p>
<b>NITRBORE</b>	<p>Boron nitride</p>
<b>ACIER533</b>	<p>Steel SA533 grade B</p>
<b>ACIER508</b>	<p>A508 carbon steel</p>
<b>INOXVES<sup>2</sup></b>	<p>Stainless steel</p>

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 775/851

INOX304 INOX316 INOX347 INCON600 INCON690 INCON718 INCON800 INCON625 LOB14948 CERAMIC NI201 LOB14571 GAP ZIRCALOY AL2O3 XXXXXXi	304 stainless steel 316 stainless steel 347 stainless steel Inconel 600 Inconel 690 Inconel 718 Inconel 800 Inconel 625 1.4948 (Lobi Loop) Ceramic (Al <sub>2</sub> O <sub>3</sub> ) Ni 201 1.4571 (Lobi Loop) 100% Helium zircaloy Al <sub>2</sub> O <sub>3</sub> (Alumin for REBEKA) (i=1,6) user defined material name (FWMAXX subroutine to be defined in the range 28 to 33 )	
YYYYYYij	(i=1,50) Name given to a material defined with the MATERIAL operator <b>NB:</b> Materials will be given in increasing order of diameters .	

To be  
re-  
peated  
as  
many  
times

### \*Radial mesh

The radial mesh data (m) will be given in increasing order.

⇒ Two possibilities to enter the radial mesh of the wall

#### 1) DATA nm1

: keyword indicating that the radial mesh will be defined mesh by mesh by the user. This is followed by an integer > 0 defining the number of meshes in the thickness of the wall. **nm1 must be the same for all segments of the exchanger.**

Two possibilities:

a) The diameters or thicknesses are constant along the segment:

: keyword indicating that the diameters are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the diameters of each radial mesh.

#### DIAM d1 d2

...

#### dnm1+1

or

#### THICK d1 d2

...

#### dnm1+1

: keyword indicating that the thicknesses are constant all along the segment. This is followed by nm1+1 real numbers > 0. defining the thickness of each radial mesh:

The first value (d1) has no real meaning, it is a reference value:  
 $d2 = d1 + \text{thickness\_radial\_mesh\_cell1}$ , etc...

To be  
re-  
peated  
as  
many  
times

To be  
re-  
peated  
as  
many  
times

<sup>1</sup>Beware that **CATHARE**  $\rho \times Cp$  values have been found to be strongly underestimated

<sup>2</sup>Beware that **CATHARE**  $\rho \times Cp$  values have been found to be false (<0.) above 890°C

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 776/851

<p>or</p> <p><b>b)</b> The diameters or thicknesses vary linearly along the segment. The diameters or thicknesses at the start and at the end of the segment are then given. Diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by <u>linear interpolation</u> between the values given at the start and end of the segment.</p> <p><b>DINI d11 d21</b> : keyword followed by nm1+1 real numbers &gt; 0. defining diameters at the start of the segment. ... <b>dnm11+1</b> or</p> <p><b>THINI d11 d21</b> : keyword followed by nm1+1 real numbers &gt; 0. defining thicknesses at the start of the segment. ... <b>dnm11+1 (case of a PLANE wall)</b> The first value (d11) has no real meaning: <math>d21 = d11 + \text{thickness\_radial\_mesh\_cell1}</math>, etc...</p> <p><b>DEND d12 d22</b> : keyword followed by nm1+1 real numbers &gt; 0. defining diameters at the end of the segment. ... <b>dnm12+1</b> or</p> <p><b>THEND d12 d22</b> : keyword followed by nm1+1 real numbers &gt; 0. defining thicknesses at the end of the segment. ... <b>dnm12+1 (case of a PLANE wall)</b> The first value (d12) has no real meaning: <math>d22 = d12 + \text{thickness\_radial\_mesh\_cell1}</math>, etc...</p> <p><b>Warning</b> : In the present version, nm1 must be the same for all the segments of a single wall.</p> <p><b>2) ISO nm1</b> : keyword indicating that the radial mesh is automatically isovolume. This is followed by an integer &gt; 0 defining the number of meshes in the thickness of the wall. In the present version, <b>nm1 must be the same for all segments of the exchanger</b>.</p> <p>Two possibilities :</p> <p><b>DIAM di dext</b> <b>a)</b> The diameters or thicknesses are <u>constant</u> along the segment : : keyword indicating that diameters are constant all along the segment. This is followed by 2 real numbers &gt; 0 defining the internal and external diameters of the wall.</p> <p>or <b>THICK di dext</b> (case of a PLANE wall) : keyword indicating that thicknesses are constant all along the segment. This is followed by 2 real numbers &gt; 0.</p> <p>The first value is a reference value and the second one the first value added to the thickness of the wall.</p> <p><b>or</b> <b>b)</b> The diameters or thicknesses vary linearly along the segment. The diameters at the start and at the end of the segment are then given. The diameters or thicknesses of the radial meshes will be calculated for all the axial meshes of the segment by <u>linear interpolation</u> between the values given at the start and end of the segment.</p>		<p><b>To be re-peated as many times as number of materials</b></p> <p><b>To be re-peated as many times as number of segments</b></p>
---	--	--

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 777/851

<b>DINI di1 dext1</b> or <b>THINI di1 dext1</b> (case of a PLANE wall)	: keyword followed by two real numbers > 0. defining the internal and external diameters at the start of the segment.  : keyword followed by two real numbers > 0. The first value is a reference value and the second one the first value added to the thickness of the wall at the start of the segment.
<b>DEND di2 dext2</b> or <b>THEND di2 dext2</b> (case of a PLANE wall)	: keyword followed by two 2 real numbers > 0. defining internal and external diameters at the end of the segment.  : keyword followed by two real numbers > 0. The first value is a reference value and the second one the first value added to the thickness of the wall at the end of the segment.

**Warning :** In the present version, nm1 must be the same for all the segments of a single wall.

<b>*Contact resistance</b>  <b>RESIST</b>  <b>VALUE hres</b> or <b>MODEL YYYYYYij</b>  <b>HEATFLUX</b> or <b>TEMP</b>  <b>RIGHT</b> or <b>LEFT</b>	To simulate a contact resistance between two materials of a given WALL. It can be located only at a specified material change radial location.  <b>Warning:</b> only one such conduction specific feature is allowed in the radial direction of each elementary wall.  OPTIONAL keyword to indicate that a contact resistance model is going to be defined. means that the value of heat transfer coefficient is imposed to the real number hres (W/m <sup>2</sup> /K).  means that the value of the heat transfer resistance coefficient is calculated by the code from the user's material "YYYYYYij". In that case, the heat transfer resistance coefficient can be correlated with the heat flux intensity through the contact resistance.  OPTIONAL keyword to indicate that the heat transfer resistance coefficient calculated in the user's material "YYYYYYij" depends either on the heat flux intensity crossing the contact resistance or on the local temperature. Default value is HEATFLUX means that the contact resistance is spread on the first mesh of the next radial material.  means that the contact resistance is spread on the last mesh of the previous radial material.	<b>To be repeated as many times as number of segments</b>
--	--	---

<b>*Heating perimeter</b>  <b>HPERIM</b>	: keyword indicating that the heating perimeter is to be given. <b>Warning :</b> HPERIM can be different from the hydraulic friction perimeter  ⇒ Two possibilities to enter the heating perimeter :	<b>To be repeated as many times as number of segments</b>
--	---	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 778/851

The heating perimeters for all the axial meshes located between the 2 vector points on which the heating perimeter is given will be calculated by linear interpolation between the values of these two points.

### 1) POINT

: if the heating perimeter is given on certain vector points of the segment. In this case the vector points of the origin and extremity of the segment must imperatively be included in the list of vector points entered. This keyword is followed by as many Pp perip groups as necessary with :

: vector point belonging to the axial meshing of the segment.

**ip**  
or  
**ip1 AND ip2**  
**AND .. ipn**  
**Perip**

: a list of vector points having the same heating perimeter and belonging necessarily to the axial meshing of the segment.

: real number > 0. defining the heating perimeter (m) on these points.

### 2) CONST peri

The heating perimeter is constant all along the segment.

: keyword indicating that the heating perimeter is constant all along the segment. This is followed by a real number > 0. defining the heating perimeter (m).

### MULTH

: OPTIONAL keyword used to modify the standard heat exchange correlation. This is to account for heat exchange devices such as fins ; such devices cannot be properly simulated by a modification of the heating perimeter. This keyword is followed by :

: value of the multiplicative coefficient for the inner side of the wall

**xhint**

: value of the multiplicative coefficient for the outside of the wall

### \*Case of a heat SOURCE

#### SOURCE

: OPTIONAL keyword informing the system that heat sources exist in the wall. By default there are no sources. This keyword is followed by :

#### MEDIUM miq1

: keyword followed by an integer > 0. defining the index of the heating medium. (Index is the rank of the material starting from the center).

#### LAW law1

: keyword followed by a law defining a power multiplication factor as a function of time (LAW 'TIME' 'POWER'). This law must be the same for all the segments

**NB** : Several materials in a wall can receive internal heat power if the law is the same for all.

**Warning** : In the present version, only one law can be used for a given wall.

⇒ Two possibilities to enter the volumetric power :

**1)** Case where the volumetric power is constant or given for each of the axial meshes of the segment.  
We then find :

#### VOLPOWER

: keyword indicating that the volumetric power is to be given

To be  
repeated as  
many times  
as number of  
segments

	<p style="text-align: right;">DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
<b>Document technique DEN</b>	Page 779/851

<b>puis1</b> <b>or</b> <b>list1</b> <b>PINI puisini</b> <b>PEND puisfin</b>	: real number defining the volumetric power (W/m <sup>3</sup> ). (if the volumetric power is given on each of the axial meshes of the segment) : : realist object (see REALLIST directive) defining the value of the volumetric power (W/m <sup>3</sup> ) on each of the axial meshes of the segment. <b>2)</b> Case where the volumetric power is calculated by linear interpolation between the volumetric powers at the start and end of the segment. : keyword followed by a real number defining the volumetric power (W/m <sup>3</sup> ) at the start of the segment. : keyword followed by a real number defining the volumetric power (W/m <sup>3</sup> ) at the end of the segment.
---	---

#### \*Case of an exchange with the outside environment

<b>LOSS</b> <b>RADEXT</b>  <b>EEXT</b>  <b>eext1</b> <b>or</b>	: OPTIONAL keyword, informing the system that an exchange exists with the outside. By default there is no exchange. : OPTIONAL keyword, informing the system that an radiative exchange exists with the outside. By default there is no radiative exchange.  ⇒ <b>Three</b> possibilities to enter the exchange with the outside environment :  <b>Warning</b> : Radiative exchange ( <b>case A</b> ) may be combinated with the convective exchange ( <b>case B or C</b> )  <b>A) : Case where the exchange is defined by a non-dimensional surface emissivity and an outside temperature</b>  ⇒ Two possibilities to define the non-dimensional surface emissivity exchange coefficient :  <b>1)</b> Case where the non-dimensional surface emissivity used for radiation heat transfer coefficient is constant or given for each of the axial meshes of the segment. Then the following keywords are to be used :  : keyword indicating that the non-dimensional surface emissivity used for radiation heat transfer is to be given. If the non-dimensional surface emissivity used for radiation heat transfer is constant on all the axial meshes of the segment: : real number = 0. and = 1. representing the non-dimensional surface emissivity used for radiation heat transfer.  (if the non-dimensional surface emissivity used for radiation heat transfer is given on each of the axial meshes of the segment) :	<b>To be repeated as many times as number of segments</b>
--	--	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	<a href="#">Page 780/851</a>

**liste1**

: realist object (see REALIST directive) defining the value of the non-dimensional surface emissivity used for radiation heat transfer on each of the axial meshes of the segment.

2)

Case where the non-dimensional surface emissivity used for radiation heat transfer is calculated by linear interpolation between the non-dimensional surface emissivities at the start and end of segment :

**EINI eexini**

: keyword followed by a real number = 0. defining the non-dimensional surface emissivity used for radiation heat transfer at the start of the segment.

**EEND eexfin**

: keyword followed by a real number = 0. defining the non-dimensional surface emissivity used for radiation heat transfer at the end of the segment.

⇒ Two possibilities to enter the outside temperature :

1)

Case where the outside temperature is constant or is given for each of the axial meshes of the segment. We then find :

**TEXT**

: keyword indicating that the outside temperature is to be given. If the outside temperature is constant on all the axial meshes of the segment, we give :

**text1**

: real number > -273. defining the outside temperature (°C).

or

if the outside temperature is given on each of the axial meshes of the segment :

**listt1**

: realist object (see REALIST directive) defining the value of the temperature on each of the axial meshes of the segment (°C).

2)

Case where the outside temperature is calculated by linear interpolation between the outside temperature at the start and end of the segment.

**TINI texini**

: keyword followed by a real number > -273.0 (°C) defining the outside temperature at the start of the segment.

**TFIN texfin**

: keyword followed by a real number > -273.0 (°C) defining the outside temperature at the end of the segment.

**B) : Case where the exchange is entered by a convective exchange coefficient and an outside temperature**

⇒ Two possibilities to enter the convective exchange coefficient:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 781/851

1) Case where the convective exchange coefficient is constant or given for each of the axial meshes of the segment.  
We then find :

**HEXT** : keyword indicating that the convective exchange coefficient is to be given. If the convective exchange coefficient is constant on all the axial meshes of the segment, we give :

**hext1** : real number  $> 0$ . defining the convective exchange coefficient ( $\text{W/m}^2 /^\circ\text{C}$ ).

**or** (if the convective exchange coefficient is given on each of the axial meshes of the segment) :

**listh1** : realist object (see REALIST directive) defining the value of the convective exchange coefficient ( $\text{W/m}^2 /^\circ\text{C}$ ) on each of the axial meshes of the segment.

2) Case where the convective exchange coefficient is calculated by linear interpolation between the convective exchange coefficients at the start and end of segment :

**HINI hexini** : keyword followed by a real number  $> 0$ . defining the convective exchange coefficient at the start of the segment ( $\text{W/m}^2 /^\circ\text{C}$ ).

**HEND hexfin** : keyword followed by a real number  $> 0$ . defining the convective exchange coefficient at the end of the segment ( $\text{W/m}^2 /^\circ\text{C}$ ).

⇒ Two possibilities to enter the outside temperature :

1) Case where the outside temperature is constant or given for each of the axial meshes of the segment.  
We then find :

**TEXT** : keyword indicating that the outside temperature is to be given. If the outside temperature is constant on all the axial meshes of the segment, we give :

**text1** : real number  $> -273$ . defining the outside temperature ( $^\circ\text{C}$ ).

**or** if the outside temperature is given on each of the axial meshes of the segment :

**listt1** : realist object (see REALIST directive) defining the value of the temperature on each of the axial meshes of the segment ( $^\circ\text{C}$ ).

2) Case where the outside temperature is calculated by linear interpolation between the outside temperature at the start and end of the segment.

**TINI texini** : keyword followed by a real number  $> -273.0$  ( $^\circ\text{C}$ ) defining the outside temperature at the start of the segment.

**TEND texfin** : keyword followed by a real number  $> -273.0$  ( $^\circ\text{C}$ ) defining the outside temperature at the end of the segment.

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 782/851

**C) Case where the exchange is entered by  
an exchange flux with the outside environment :**

⇒ Two possibilities to enter the exchange flux :

- 1) Case where the exchange flux is constant or given for each of the axial meshes of the segment. One then finds :

**PHIEXT** : keyword indicating that the exchange flux is to be given. If the exchange flux is constant over the entire segment, one gives :

**phiext1** : real number defining the exchange flux [W/m<sup>2</sup> ]. The flux is lost by the wall if ( $\varphi_{ext} < 0.$ ) and received if ( $\varphi_{ext} > 0.$ ).

**or** (if the exchange flux is given on each axial meshes of the segment)

**list1** : realist object (see REALLIST directive) defining the value of the exchange flux (W/m<sup>2</sup> ) on each of the axial meshes of the segment.

- 2) Case where the exchange flux is calculated by linear interpolation between the exchange flux at the start and end of the de segment :

**PHIINI phiini** : keyword followed by a real number defining the exchange flux [W/m<sup>2</sup> ]

(positive or negative) at start of segment

**PHIFIN phifin** : keyword followed by a real number defining the exchange flux [W/m<sup>2</sup> ] (positive or negative) at the end of the segment

**\*Case of a 0D steam generator**

**POINTSG** : OPTIONAL keyword informing the system that a POINTSG type exchange is to be given in the form of an exchange coefficient.

**Warning** : if a segment is declared POINTSG, it cannot have neither a SOURCE term nor a LOSS term.

⇒ Two possibilities to enter the exchange coefficient :

- 1) Case where the exchange coefficient is constant or is given for each of the axial meshes of the segment. One then finds :

**HEXT** : keyword indicating that the exchange coefficient is to be given. If the exchange coefficient is constant on all the axial meshes of the segment, we give :

**hext1** : real number > 0. defining the exchange coefficient (W/m<sup>2</sup> /°C).

**or** (if the exchange coefficient is given on each of the axial meshes of the segment) :

To be  
repeated as  
many times  
as number of  
segments

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 783/851

<b>listh1</b>  <b>2)</b>  <b>HINI hexini</b>  <b>HEND hexfin</b>	<p>: initial object (see REALIST directive) defining the value of the exchange coefficient (<math>\text{W/m}^2 /^\circ\text{C}</math>) on each of the axial meshes of the segment.</p> <p>Case where the exchange coefficient is calculated by <u>linear interpolation</u> between the exchange coefficients at the start and end of segment :</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the exchange coefficient (<math>\text{W/m}^2 /^\circ\text{C}</math>) at the start of the segment.</p> <p>: keyword followed by a real number <math>&gt; 0</math>. defining the exchange coefficient (<math>\text{W/m}^2 /^\circ\text{C}</math>) at the end of the segment.</p>
--	--

Examples
----------

1) wall2 =  2) wall4 =  3) wall8 =  listpow =  SEGMENT	<pre> WALL      downco    EXTERNAL   SEGMENT    p3        p6 ACIER533  DATA 2    DIAM       3.988     4.088    4.478 HPERIM     CONST     12.529 ;</pre> <pre> WALL      coeurmoy  INTERNAL   SEGMENT    P8        P11 mgo       ISO        1          DIAM       0.        1.d-3 tophet   ISO        1          DIAM       1.d-3    2.4d-3 mgo       ISO        1          DIAM       2.4d-3   8.36d-3 RESIST    VALUE     1.0D+2   RIGHT      2.9845d-2 incon800 ISO        2          DIAM       8.36d-3   9.5d-3 HPERIM    CONST     1 LAW     law1      VOLPOWER  listpow1 SOURCE    MEDIUM   4 LAW     law1      VOLPOWER  listpow4;</pre> With law1 and listpow previously defined as law1=LAW listpow =  SEGMENT	<p>'time'</p> <p>'power'</p> <p>0.           1. 100.         1.;</p> <p>23.681E8    23.681E8 23.681E8    33.999E8 79.109E8    82.259E8 64.811E8    55.836E8 23.681E8    23.681E8 ;</p> <p>steamgen    EXTERNAL P12          ACIER533 P16          DATA               2          DIAM               .7366    .7766    .8656 HPERIM      POINT    (p12 P16          P17      ACIER533 DATA         2          AND     p16)      2.3141               DINI</p>
---	--	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	<a href="#">Page 784/851</a>

			.7366	.7766	.8656	
			DEND			
			3.1466	3.2	3.25	
		HPERIM	POINT			
			p16	2.3141	p17	8.065
SEGMENT	P17		ACIER533			
			2 DIAM			
			3.1466	3.2	3.25	
		HPERIM	POINT			
			p17	8.065	p18	107.
			MULTH	1.D0		
SEGMENT	P18		ACIER533			
			P19			
			DATA	2	DIAM	
				.01968	.034	.04884
		HPERIM	POINT			
			p18	107.	p19	205.935 ;
4) wallz =						
	WALL	steamgen	INTERNAL	SEGMENT	p3	p6
	ACIER533	DATA	2	DIAM		
			0.012	0.025	0.035	
	HPERIM	CONST	12.529			
	POINTSG	HEXT	40.D3 ;			

## 252.2 Wall on a TEE-branch element

This feature was available in V1.3 ; it is not available anymore. The TEE is a sub-component integrated to a standard AXIAL module, the WALL is only attached to this AXIAL module and no wall need to be attached to the TEE.

## 252.3 Wall on a 0-D element

The order of the keywords indicated below must be respected.

### Syntax

**Warning :** DIAM keyword is relating to CYLINDER walls, THICK is relating to PLANE walls

p1 =	<b>WALL</b>	elem			
			<b>INTERNAL</b>	or	<b>EXTERNAL</b>
			(CYLINDER)	or	(PLANE)
			(RADIATW)		
			<b>ELEV</b>	zmini	zmaxi

 <b>DE LA RECHERCHE À L'INDUSTRIE</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 785/851

	material1				
	<b>DATA</b>	nm1	<b>DIAM</b>	(or	<b>THICK</b>
			d1	d2...	dnm1+1
	or				
	<b>ISO</b>	nm1	<b>DIAM</b>	(or <b>THICK</b> )	
			di	dext	
	(RESIST	<b>VALUE</b>	hres	<b>RIGHT</b>	
			or	<b>LEFT</b>	
	or	<b>MODEL</b>	<b>YYYYYYij</b>	<b>RIGHT</b>	
				or <b>LEFT</b> )	
		(material2)			
		...			
	<b>HPERIM</b>	per1			
	( <b>MULTH</b>	xhint	xhext )		
(SOURCE	<b>MEDIUM</b>	miq1	<b>LAW</b>	law1	
	<b>VOLPOWER</b>	puis1	or	list1	
		(SOURCE ..)			
	<b>LOSS</b>	<b>(RADEXT</b>			
		<b>EEXT</b>	eext1		
		<b>(TEXT</b>	text1 )		
and/or					
		<b>HEXT</b>	hext1		
		<b>TEXT</b>	text1		
		or			
		<b>PHIEXT<sup>1</sup></b>	phiext1		
		;			

**elem** : volume element

**INTERNAL** : keyword indicating that the wall is internal with respect to the flow. In cases where the wall is external with respect to the flow, **INTERNAL** will be replaced by the keyword **EXTERNAL**.

**PLANE** : OPTIONAL keyword indicating that the wall is a plane wall ( by default, walls are **CYLINDER**).Then you should use keyword **THICK** to define the radial meshing instead of **DIAM**.

**RADIATW** : OPTIONAL keyword indicating that the radiation heat transfer over 5 bars will be limited to its value for 5 bars.

<sup>1</sup>phiext1 > 0 means heat given to the wall

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 786/851

**ELEV** : keyword indicating that the lower and upper elevations of the wall are to be read.

**Warning:** The definition of several walls belonging to the same element is possible using different wall operators. The modeling of several wall portions using the ELEV keyword is not allowed. Only one ELEV keyword is allowed in a wall definition.

This is followed by :

**Zmini** : real number > 0. defining the lower elevation of the wall (m).

**Zmaxi** : real number > 0. defining the upper elevation of the wall (m).

<b>material1</b> : imposed keyword defining the nature of the material used, to select from the following list :	<b>To be repeated as many times as number of materials</b>
MGO	
TOPHET <sup>1</sup>	
NITRBORE	
ACIER533	
ACIER508	
INOXVES <sup>2</sup>	
INOX304	
INOX316	
INOX347	
INCON600	
INCON690	
INCON718	
INCON800	
INCON625	
LOB14948	
CERAMIC	
NI201	
LOB14571	
GAP	
ZIRCALOY	
AL2O3	
XXXXXXi	
YYYYYYij	

(i=1,50) Name given to a material defined with the MATERIAL operator

**NB:** Materials will be given in increasing order of diameters.

#### **\*Radial mesh**

The radial mesh data (m) will be given in increasing order.

⇒ Two possibilities to enter the radial mesh of the wall

<sup>1</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be strongly underestimated

<sup>2</sup>Beware that CATHARE  $\rho \times Cp$  values have been found to be false ( $<0$ ) above 890°C

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/12-040/A</i>
	<b>Document technique DEN</b>	Page 787/851

<b>1) DATA nm1</b>  <b>DIAM d1 d2</b> ... <b>dnm1+ 1</b> or <b>THICK d1 d2</b> ... <b>dnm1+ 1</b>	: keyword indicating that the radial mesh will be defined mesh by mesh by the user. This is followed by an integer $> 0$ defining the number of meshes in the thickness of the wall. <b>nm1 must be the same for all segments of the exchanger.</b>	<b>To be repeated as many times as number of materials</b>
	: keyword indicating that the diameters are constant all along the segment. This is followed by $nm1+1$ real numbers $> 0$ . defining the diameters of each radial mesh.  : keyword indicating that the thicknesses are constant all along the segment. This is followed by $nm1+1$ real numbers $> 0$ . defining the thickness of each radial mesh: The first value (d1) has no real meaning , it is a reference value; $d2 = d1 + \text{thickness\_radial\_mesh\_cell1}$ , etc...	
<b>2) ISO nm1</b>  <b>DIAM di dext</b>  or <b>THICK di dext</b> (case of a PLANE wall)	: keyword indicating that the radial mesh is automatically isovolume. This is followed by an integer $> 0$ defining the number of meshes in the thickness of the wall. In the present version, <b>nm1 must be the same for all segments of the exchanger.</b>  : keyword indicating that diameters are constant all along the segment. This is followed by 2 real numbers $> 0$ defining the internal and external diameters of the wall.  : keyword indicating that thicknesses are constant all along the segment. This is followed by 2 real numbers $> 0$ .	
	The first value is a reference value and the second one the first value added to the thickness of the wall.	

**\*Contact resistance**  
To simulate a contact resistance between two materials of a given WALL. It can be located only at a specified material change radial location  
**Warning:** only one such conduction specific feature is allowed in the radial direction of each elementary wall.

<b>RESIST</b> <b>VALUE hres</b> or <b>MODEL</b> <b>YYYYYYij</b>	OPTIONAL keyword to indicate that a contact resistance model is going to be defined. value of the heat transfer resistance coefficient ( $\text{W}/\text{m}^2/\text{K}$ ).
<b>RIGHT</b> or <b>LEFT</b>	means that the value of the heat transfer resistance coefficient is calculated by the code from the user's material "YYYYYYij". In that case, the heat transfer resistance coefficient can be correlated with the heat flux intensity through the contact resistance means that the contact resistance is spread on the first mesh of the next radial material. means that the contact resistance is spread on the last mesh of the previous radial material.
<b>HPERIM</b>	: keyword indicating that the heating perimeter is to be given. <b>Warning :</b> HPERIM can be different from the hydraulic friction perimeter
<b>MULTH</b>	: OPTIONAL keyword used to modify the standard heat exchange correlation. This is to account for heat exchange devices such as fins ; such devices cannot be properly simulated by a modification of the heating perimeter. This keyword is followed by :

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 788/851

**xhint** : value of the multiplicative coefficient for the inner side of the wall  
**xhext** : value of the multiplicative coefficient for the outside of the wall

#### **\*Case of a heat SOURCE**

**SOURCE** : OPTIONAL keyword informing the system that heat sources exist in the wall. By default there are no sources. This keyword is followed by :

**MEDIUM miq1** : keyword followed by an integer  $> 0$ . defining the index of the heating medium. (Index is the rank of the material, starting from the center).

**LAW law1** : keyword followed by a law defining a power multiplication factor as a function of time (LAW 'TIME' 'POWER'). This law must be the same for all the segments  
**NB** : Several materials in a wall can receive internal heat power if the law is the same for all.  
**Warning** : In the present version, only one law can be used for a given wall.

**VOLPOWER puis1** : keyword indicating that the volumetric power is to be given  
: real number defining the volumetric power ( $\text{W}/\text{m}^3$ ).  
**NB** : Several materials in a wall can receive internal heat power if the law is the same for all.

#### **\*Case of an exchange with the outside environment**

**LOSS** : OPTIONAL keyword, informing the system that an exchange exists with the outside. By default there is no exchange.

**RADEXT** : OPTIONAL keyword, informing the system that an radiative exchange exists with the outside. By default there is no radiative exchange.

⇒ **Three** possibilities to enter the exchange with the outside environment :

**Warning:** Radiative exchange (**case A**) may be combined with the convective exchange (**case B or C**)

**A) : Case where the exchange is defined by a non-dimensional surface emissivity and an outside temperature**

**EEXT** : keyword indicating that the non-dimensional surface emissivity used for radiation heat transfer is to be given. If the non-dimensional surface emissivity used for radiation heat transfer is constant on all the axial meshes of the segment:  
**eext1** : real number = 0. and = 1. representing the non-dimensional surface emissivity used for radiation heat transfer.

**TEXT** : keyword indicating that the outside temperature is to be given. If the outside temperature is constant on all the axial meshes of the segment, we give :  
**text1** : real number  $> -273$ . defining the outside temperature ( $^{\circ}\text{C}$ ).

**B) : Case where the exchange is entered by a convective exchange coefficient and an outside temperature**

		<p style="margin: 0;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
	<b>Document technique DEN</b>	Page 789/851

**HEXT** : keyword indicating that the convective exchange coefficient is to be given. If the convective exchange coefficient is constant on all the axial meshes of the segment, we give :

**hext1** : real number  $> 0$ . defining the convective exchange coefficient ( $\text{W}/\text{m}^2/\text{°C}$ ).

**TEXT** : keyword indicating that the outside temperature is to be given. If the outside temperature is constant on all the axial meshes of the segment, we give :

**text1** : real number  $> -273$ . defining the outside temperature ( $\text{°C}$ ).

C) Case where the exchange is entered by  
an exchange flux with the outside environment :

**PHIEXT** : keyword indicating that the exchange flux is to be given. If the exchange flux is constant over the entire segment, one gives :

**phiext1** : real number defining the exchange flux [ $\text{W}/\text{m}^2$ ]. The flux is lost by the wall if ( $\varphi_{ext} < 0$ ) and received if ( $\varphi_{ext} > 0$ ).

### Example

wall3 =	WALL	voling	EXTERNAL	ELEV	0.	3.0168
	RESIST	MODEL	YYYYYYY24	RIGHT		
	acier533	DATA	2			
		DIAM	9.	9.04	9.1758	
	HPERIM	28.270				
	LOSS	RADEXT				
		EEXT	0.8D0	TEXT	90.D0	;
Wall4 =	WALL	voling	EXTERNAL	ELEV	0.	3.0168
	acier533	DATA	2			
		DIAM	9.	9.04	9.1758	
	HPERIM	28.270				
	LOSS	MULTH	1.5D0	1.D0		
		RADEXT	EEXT	0.8D0		
		HEXT 20.D0	TEXT	90.D0		;

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 790/851

253

## WCIRCBA DIRECTIVE

The **WCIRCBA** directive is used to set-up the value of radio-chemical components variables in all the elements of a given circuit or zone. These variables have imposed names known as “Cathare Computation Variables” (CCV). Access must be performed in *command block*.

### Associated Keywords

**ACTEMIS, SCRAM, WRIBA, VALBA, RADCHEMI, ACCU, INIBORA, GOBORA, ZONBAMOY**

**NB :** The corresponding FORTRAN subroutine called in PILOT is CICRIBA: CALL CICRIBA (OBJNAM , KEYWOR, BNAME, ITYPE,VALWRI, IVALWRI, CVALWRI, \*9999 )

OBJNAM	CHARACTER*8 name of the circuit
KEYWOR	CHARACTER*8 variable name GLOBAL_NAMEVAR or NAMEVAR if BNAME is not used
BNAME	CHARACTER*8 radio chemical name
ITYPE	INTEGER value giving the type of the value to be imposed:
CVALWRI	CHARACTER*8 imposed value if ITYPE = 3
IVALWRI	INTEGER imposed value if ITYPE = 2
VALWRI	DOUBLE PRECISION imposed value if ITYPE = 1

### Syntax

<b>WCIRCBA</b>	xval	<b>GLOBAL_NAMEVAR</b>
		circuit1       obj                   ( compo );
	or	<b>NAMEVAR</b>

<b>xval</b>	: real number to be written
<b>GLOBAL_NAMEVAR</b> :	name of an overall variable of the circuit.
<b>NAMEVAR</b>	: name of a variable attached to a component.
<b>circuit1</b>	: circuit or zone name.
<b>obj</b>	: integer equal to metricconverterProductID0 in0 in that case (circuit).

	<p style="text-align: right;"><i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i></p>
<b>Document technique DEN</b>	Page 791/851

**compo** : optional variable, only used with NAMEVAR, giving the name of the radio-chemical component for which the value is going to be written (the list of pre-defined components is given in the description of the RADCHEMI operator).

**N.B.** : When changing a variable in a circuit, the variable is changed in every element of the circuit.

**Names of the variables which can be written:**

GLOBAL_NAMEVAR	
FLAGIEA	integer to indicate the Emergency Shutdown state (ON=1 – OFF=0) to be used in the circuit including the fuel wall.
NAMEVAR	
HFLIFE	real representing the half-life period (s) <sup>1</sup>
KA_CST	weight of one GBq <sup>1</sup>
HENRY_	Henry constant <sup>1</sup>
EVAPOR	entrainment coefficient due to vaporization <sup>2</sup>
CONDEN	entrainment coefficient due to condensation <sup>2</sup>
DISSOL	dissolution time constant <sup>2</sup>
DEGASA	time constant associated to the gas stripping <sup>2</sup>
RCVEFF	efficiency of the Chemical and Volume Control filters <sup>1</sup>
RELACH	emission rate (cf IMR_NB) <sup>3</sup>
AMPLIF	amplifying factor of the rate of emission (IMR=0) <sup>3</sup> This variable (related only to fission products) must be assigned in the circuit including the fuel wall.
IDP_NB	integer to indicate the management mode of the activity peak duration <sup>3</sup> =0 : “ratio” is the primary mean specific activity amplification factor =1 : “ratio” is the peak duration This flag is to be switched in the circuit including the element holding the fuel wall. The meaning of the “ratio” constant is then changed, and the “ratio” constant should be modified (see RADCHEMI operator).
RATIO_	activity ratio or peak duration (cf IDP_NB) <sup>3</sup>

<sup>1</sup>To be modified simultaneously in every circuit.

<sup>2</sup>The WRIBA directive should be used if different values are to be written within elements of a same circuit. The default value is the value assigned through the RADCHEMI operator.

<sup>3</sup>To be modified in the circuit including the fuel wall.

<b>DE LA RECHERCHE À L'INDUSTRIE</b>  <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 792/851</a>

254

## WRIBA DIRECTIVE

The **WRIBA** directive is used to impose the value of radio-chemical components variables with imposed names, known as “Cathare Computation Variables” (CCV) as the WRITE directive does for all the others variables. Access must be performed in *command block*.

**Warning :**Using the WRIBA directive to impose values on an element is not a normal use of CATHARE, especially it is a nonsense imposing the following variables in an element when they must be global to the whole circuit or zone. The directive WCIRBA must be used instead of WRIBA. It is the reason why **WRIBA is intended to be used in special case by well-informed user**, except for a SOURCE or a SINK to impose flowrates.

It may be used to re-initialize a component in a part of a circuit.

### Associated Keywords

ACTEMIS, SCRAM, VALBA, RADCHEMI, ACCU, INIBORA, GOBORA, WCIRCB, ZONBAMOY, VALBA, VALUE, WRITE, SENSOR, VALUEFLD, (MPa)UTILx

**NB :** The corresponding FORTRAN subroutine called in PILOT is :

ECRIBA for DOUBLE PRECISION type variables : CALL ECRIBA (VALWRI, KEYWOR, OBJNAM, IMESH, IRAD, BANAME, \*9999)

ECRIBAI for INTEGER type variables : CALL ECRIBAI (IVALWRI, KEYWOR, OBJNAM, IMESH, IRAD, BANAME, \*9999)

VALWRI	DOUBLE PRECISION value to impose
IVALWRI	INTEGER value to impose
KEYWOR	CHARACTER*8 name of the variable to be modified
OBJNAM	CHARACTER*8 name of the element
IMESH	INTEGER mesh number – 0 if no mesh number, 1 for lower sub-volume , 2 for upper sub-volume
IRAD	INTEGER 0, no meaning
BANAME	CHARACTER*8 name of the radio-chemical component

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 793/851

## 254.1 CCVs imposed in an ELEMENT

### Syntax

**WRIBA**      xval  
                 or      **GLOBAL\_NAMEVAR**      elem1      obj      ( compo );  
**NAMEVAR**

**xval** : real number to be written.  
**GLOBAL\_NAMEVAR**: name of an overall variable of the circuit or of the zone.  
**NAMEVAR** : name of a variable attached to a component.  
**elem1** : element name.  
**obj** : argument defined in the table below (mesh number , SUP or INF).  
**compo** : OPTIONAL variable, only used if NAMEVAR, giving the name of the radio-chemical component for which the value is written (the list of pre-defined components is given in the description of the RADCHEMI operator).

s	scalar point
m	highest sub-volume : keyword SUP lowest sub-volume : keyword INF
0	overall variable
no	not available

### Names of the variables which can be written :

	<b>Description</b>	<b>value of obj</b>				
		<b>1-D</b>	<b>0-D</b>	<b>3-D</b>	<b>BC</b>	<b>RG</b>
<b>GLOBAL_NAMEVAR</b>						
FLAGIEA	integer to indicate the Emergency Shutdown state : ON=1 – OFF=0	0		0		
<b>NAMEVAR</b>						
EVAPOR	entrainment coefficient due to vaporisation <sup>2</sup>	s	m	s	no	no
CONDEN	entrainment coefficient due to condensation <sup>2</sup>	s	m	s	no	no
DISSOL	dissolution time constant <sup>2</sup>	s	m	s	no	no
DEGASA	time constant associated to the gas stripping <sup>2</sup>	s	m	s	no	no
RELACH	- for fission products (IMR = 0) : release rate (in GBq/s) before Emergency Shutdown - for radiolysis or activation products (IMR = 1) : proportionality factor between the activity release rate and the neutron flux <sup>1</sup>	0	no	0	no	no
AMPLIF	amplifying factor of the rate of emission <sup>1</sup> only for fission products (IMR=0) not used for IMR=1	0	no	0	no	no

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 794/851

IDP_NB	integer to indicate if the peak duration is used (=1) or not (=0) =0 : "ratio" is the primary mean specific activity amplification factor =1 : "ratio" is the peak duration (fission products only ; see RADCHEMI operator) <sup>1</sup>	0	no	0	no	no
IRG_NB	integer to indicate the emissive peak : ON=1 – OFF=0 <sup>1</sup>	0	0	0	0	0
RATIO_	activity ratio or peak duration (see above IDP_NB) <sup>1</sup>	0	no	0	no	no
CORUPT	Curvilinear abscissas (m) where the cladding rupture is defined <sup>1</sup>	0	no	f	no	no
PCRUPT	Percentage of ruptured rods <sup>1</sup>	0	no	f	no	no
DTRUPT	Period of time during which the rupture occurs (s) <sup>1</sup>	0	no	f	no	no
LIQFRA	specific concentration (chemical component) or specific activity (radioactive component) in the liquid phase	s	m	s	0	0
GASFRA	specific concentration (chemical component) or specific activity (radioactive component) in the gas phase	s	m	s	0	0

<sup>1</sup>Can be modified only in the element with the fuel wall.

<sup>2</sup>Different values can be assigned this way to different elements of the same circuit. The default value is the value assigned through the RADCHEMI operator.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 795/851

## 254.2 CCVs imposed in a PIQxxx gadget

### Syntax

**WRIBA**      **xval**      **NAMEVAR**      **piqxx1**      **obj**      **compo** ;

<b>xval</b>	: real number to be written.
<b>NAMEVAR</b>	: name of a variable attached to a piqxxx gadget.
<b>piqxx1</b>	: source name.
<b>obj</b>	: integer equal to 0.
<b>compo</b>	: name of the radio-chemical component for which the value is written (the list of pre-defined components is given in the description of the RADCHEMI operator).

**Warning :** Variables can only be written in “source” mode

### Names of the variables which can be written (for all PIQxxx gadgets)

<b>NAMEVAR</b>	<b>Description</b>
<b>GASFRX</b>	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the radio-chemical component in gas phase outside the element.
<b>LIQFRX</b>	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the radio-chemical component in gas phase outside the element.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 796/851

## 254.3 CCVs imposed in a SOURCE

**WRIBA            xval            NAMEVAR            source1            obj            compo ;**

<b>xval</b>	: real number to be written.
<b>NAMEVAR</b>	: name of a variable attached to a source.
<b>source1</b>	: source name.
<b>obj</b>	: integer equal to 0.
<b>compo</b>	: name of the radio-chemical component for which the value is written (the list of pre-defined components is given in the description of the RADCHEMI operator).

<b>NAMEVAR</b>	<b>Description</b>
<b>LIQFRX</b>	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the radio-chemical component in liquid phase.
<b>GASFRX</b>	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the radio-chemical component in gas phase.

### Example

**WRIBA            qchalpbo            LIQFRA            chargsou            0            BORON ;**

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 797/851

255

## WRITE DIRECTIVE

The **WRITE** directive is used to impose the value of certain variables with imposed names, known as “Cathare Computation Variables” ([CCV](#)). Access is performed in *command block*.

**Using of the WRITE directive to impose values on an element is not a normal use of CATHARE and should be avoided.**

### Associated Keywords

**VALUE, VALBA, WRIBA, SENSOR, VALUEFLD, (MPa)UTILx**

**NB :** The corresponding FORTRAN subroutine called in PILOT is :

- ECRIRE for DOUBLE PRECISION type variables: CALL ECRIRE ( RVAL, KEYWOR, CNAME, IMESH, IRAD, \*9999),
- ECRIRI for INTEGER type variables: CALL ECRIRI ( IVAL, KEYWOR, CNAME, IMESH, IRAD, \*9999),
- ECRIRC for CHARACTER\*8 type variables: CALL ECRIRC ( CVAL, KEYWOR, CNAME, IMESH, IRAD, \*9999)

RVAL	DOUBLE PRECISION value to be imposed
or IVAL	INTEGER value to be imposed
or CVAL	CHARACTER*8 to be imposed
KEYWOR	CHARACTER*8 name of the variable to be written
CNAME	CHARACTER*8 name of the element
IMESH	INTEGER mesh number – refer to s, m, v, j or r below.
IRAD	INTEGER 0 if no meaning else radial mesh number for walls, or radio-chemical number for hydraulic components
IVSTAT	INTEGER error code

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 798/851

## 255.1 CCVs imposed in the USER common

Syntax
--------

### 255.1.1 Activation of XUSER, KUSER, CUSER arrays

```

WRITE      XUSER      ci1          cp1 ;
WRITE      KUSER      ci2          cp2 ;
WRITE      CUSER      ci3          cp3 ;

```

### 255.1.2 Filling of the USER common

```

xval=      WRITE      XUSER      i1 ;
kval=      WRITE      KUSER      i2 ;
eval=      WRITE      CUSER      i3 ;

```

<b>xval</b>	: real number to be written
<b>kval</b>	: integer number to be written
<b>eval</b>	: character*8 to be written
<b>XUSER</b>	: name of the array (keyword)
<b>KUSER</b>	: name of the array (keyword)
<b>CUSER</b>	: name of the array (keyword)
<b>i1</b>	: index in the array XUSER $0 < i1 < 750$
<b>i2</b>	: index in the array KUSER $0 < i2 < 250$
<b>i3</b>	: index in the array CUSER $0 < i3 < 250$
<b>ci1</b>	: lower index in the array XUSER (ci1 should not be lower than 1)
<b>cp1</b>	: higher index in the array XUSER (cp1 should not be higher than 750)
<b>ci2</b>	: lower index in the array KUSER (ci2 should not be lower than 1)
<b>cp2</b>	: higher index in the array KUSER (cp2 should not be higher than 250)
<b>ci3</b>	: lower index in the array CUSER (ci3 should not be lower than 1)
<b>cp3</b>	: higher index in the array CUSER (cp3 should not be higher than 250)

The variables in the arrays XUSER, KUSER, and CUSER are saved with the storage frequency of the REACTOR (Check RESULT directive in your input deck).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 799/851

## 255.2 CCVs imposed in a REACTOR

### Syntax

**WRITE**      xval      **NAMEVAR**      reactor ;

**xval**                    : real number to be written  
**NAMEVAR**                : name of the variable  
**reactor**                : reactor name

#### Names of the variables which can be written:

GRAVEXT	External gravity in m/s <sup>2</sup> in case of “comete” application
---------	--

### Example

**WRITE**      0.96      GRAVEXT      CIRCTOT ;

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 800/851

## 255.3 CCVs imposed in an ELEMENT

### Syntax

```
WRITE      xval      NAMEVAR     elem      (GROUP)    (obj1)    ;
          

xval          : real number to be written
NAMEVAR       : name of the variable
elem          : element name.
                If the element (axial or bcondit) is of type GROUP, the element must be followed by
                the keyword GROUP. In that case, the value are written for all the elements of the group.
obj1          : OPTIONAL. Object defined in the table below (mesh number, junction number, SUP,
                INF, or nothing at all).
                If obj1 = -1, all the points of the element are going to be changed.
                Omitting obj1 is equivalent to specify obj1=1 (only the first mesh will be modified).
```

The values of obj1 for each type of element are given in the following table :

Characteristics of OBJ1 :

si	internal scalar point
s	scalar point
v	vector point
t	TEE number : order as defined in input deck relating to the carrying AXIAL
j	junction number, according to the definition of the object
m	higher sub-volume ⇒ keyword SUP (or +2)lower sub-volume ⇒ keyword INF (or +1)
0	nothing
-1	Same value in each mesh of an axial or threed element
	Not available

To impose a value at a junction between two elements you must write the value on the two vector nodes concerned by the junction (one for each element).

### 255.3.1 General variables

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
PRESSURE	s	m	0	s	pressure (Pa)
LIQH	s	m	0	s	enthalpy of liquid (J/kg)
GASH	s	m	0	s	enthalpy of gas (steam + noncondensable) (J/kg)
XiFRACT	s	m	0	s	mass fraction of $i^{th}$ non condensable gas
ALFA	s	m	0	s	void fraction

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 801/851

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
LIQV	v	j	0		velocity of liquid (m/s)
LIQVX				v	X component of liquid velocity (m/s)
LIQVY				v	Y component of liquid velocity (m/s)
LIQVZ				v	Z component of liquid velocity (m/s)
GASV	v	j	0		velocity of gas (m/s)
GASVX				v	X component of gas velocity (m/s)
GASVY				v	Y component of gas velocity (m/s)
GASVZ				v	Z component of gas velocity (m/s)
COEFROT1	v	j			singularity coefficient (positive wrt meshing flow direction : in → out for a volume ; upstream → downstream for an axial)
XFR1X				v	singularity coefficient along X+
XFR1Y				v	singularity coefficient along Y+
XFR1Z				v	singularity coefficient along Z+
COEFROT2	v	j			singular friction coefficient (negative wrt meshing flow direction)
XFR2X				v	singularity coefficient along X-
XFR2Y				v	singularity coefficient along Y-
XFR2Z				v	singularity coefficient along Z-
RADSTAT	0			0	radiative exchange activation flag 0 exchanges are deactivated 1 exchanges are activated

### 255.3.2 Variables for sensitivity parameters

Must be written again by the user in the restart input deck.

#### 255.3.2.1 Interface to liquid heat flux : QLE

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1QLE	si	m		si	QLE sensitivity parameter (1D, 0D)
P1QLF	si	m		si	QLE flashing sensitivity parameter
SP3QLF	si	m		si	QLE flashing delay sensitivity parameter
PQGT	si	m		si	Droplet flow sensitivity parameter for QLE

#### 255.3.2.2 Interface to vapor heat flux : QVE

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1QVE	si	m		si	QVE sensitivity parameter (1D, 0D)
SP1DGQVE	si	m		si	Droplet diameter sensitivity parameter for QVE

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 802/851

### 255.3.2.3 Wall to fluid friction coefficient

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1CL	v	j			Wall to liquid friction sensitivity parameter (1D,0D) when there is no reflooding
SP1CLR	v				Wall to liquid friction sensitivity parameter (1D,0D) in case of reflooding
SP1CLV		j			Wall to liquid friction sensitivity parameter (1D,0D)
P1CLX				v	Wall to liquid friction sensitivity parameter (3D)
P1CLY				v	along X, Y and Z respectively
P1CLZ				v	
SP1CG	v	j			Wall to steam friction sensitivity parameter (1D,0D)
P1CGX				v	Wall to steam friction sensitivity parameter (3D)
P1CGY				v	along X, Y and Z respectively
P1CGZ				v	

### 255.3.2.4 Interfacial friction :TOI

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1TOI	v	j			Toi sensitivity parameter (1D, 0D)
SP1TOX				v	X component of Toi sensitivity parameter
SP1TOY				v	Y component of Toi sensitivity parameter
SP1TOZ				v	Z component of Toi sensitivity parameter
P1TOA	v	j			Toi sensitivity parameter for annular flow
P1TOB	v	j			Toi sensitivity parameter for bubble/slug flow
P1TBX				v	Toi sensitivity parameter for bubble/slug flow
P1TBY				v	along X, Y and Z respectively
P1TBZ				v	
P1TOS	v	j			Toi sensitivity parameter for stratified flow
TOIFDT	v				Toi (1D) sensitivity parameter downstream quench front
TOZFDT				v	Toi (3D) sensitivity parameter downstream quench front
SP1ETO	v			v	Entrainment rate sensitivity parameter (Toi)
SP1ETOD					Entrainment rate sensitivity parameter (Toi) downstream the quench front in case of reflooding
SP1ETOUP					Entrainment rate sensitivity parameter (Toi) upstream the quench front in case of reflooding
SP1ETOX				vx	X component of entrainment rate sensitivity parameter (Toi)
SP1ETOY				vy	Y component of entrainment rate sensitivity parameter (Toi)
SP1ETOZ				vz	Z component of entrainment rate sensitivity parameter (Toi)
SP1ENTV	v			v	Entrainment threshold velocity sensitivity parameter (Toi)
SP1ENTVX				vx	X component of entrainment threshold velocity sensitivity parameter (Toi)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 803/851

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SP1ENTVY				vy	Y component of entrainment threshold velocity sensitivity parameter (Toi)
SP1ENTVZ				vz	Z component of entrainment threshold velocity sensitivity parameter (Toi)
SP1DGTOI	v			v	Droplet diameter sensitivity parameter for Toi
SP1DTOIX				vx	X component of droplet diameter sensitivity parameter for Toi
SP1DTOIY				vy	Y component of droplet diameter sensitivity parameter for Toi
SP1DTOIZ				vz	Z component of droplet diameter sensitivity parameter for Toi
SP1DGFDT	v			v	Droplet diameter sensitivity parameter for Toi downstream the quench front
SP1DFDTX				vx	X component of droplet diameter sensitivity parameter for Toi downstream the quench front
SP1DFDTY				vy	Y component of droplet diameter sensitivity parameter for Toi downstream the quench front
SP1DFDTZ				vz	Z component of droplet diameter sensitivity parameter for Toi downstream the quench front

### 255.3.2.5 Heat transfer

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
PQSH	si	m		si	Liquid-interface heat transfer sensitivity parameter in case of Shah correlation
PQCH	si			si	Liquid-interface heat transfer sensitivity parameter in case of Chen correlation. PQCH must be equal to PPCH.
PQSHER	si	m		si	Liquid-interface heat transfer sensitivity parameter in case of Chen correlation with non condensable gas (modification of Sherwood number). PQSHER must be equal to PPSHER
PQST	si	m		si	Liquid-interface heat transfer sensitivity parameter for stratified flows.
DTMFS	si	m		si	TMFS sensitivity parameter (bias)

### 255.3.2.6 Injection

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SCOQLES	s	s			Source (source, accu, tee) injection term (QUE, mass transfer) parameter

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 804/851

### 255.3.2.7 Volume special parameters

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
CQMOIN		0			Energy transfer due to steam condensation from upper sub-volume to lower sub-volume sensitivity parameter
CQPLUS		0			Energy transfer due to steam vaporization from lower sub-volume to upper sub-volume sensitivity parameter
VDROPF		0			Drop fall velocity in upper sub-volume sensitivity parameter.
PBTL		j			$\beta l$ sensitivity parameter. This parameter must be positive. The result of the product $\beta l * PBTL$ must belong to [0;1]. If the product is greater than 1. $\beta l$ is imposed equal to 1. and its derivatives are imposed to 0.
PBTG		j			$\beta g$ sensitivity parameter. This parameter must be positive. The result of the product $\beta g * PBTG$ must belong to [0;1]. If the product is greater than 1. $\beta g$ is imposed equal to 1. and its derivatives are imposed to 0.
PVBR		0			Rising of bubbles sensitivity parameter in lower sub-volume.

### 255.3.2.8 Additional parameter for sensitivity calculations for Tee

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
SHENT	t				Sensitivity parameter of limit level used for liquid (for horizontal and upward Tee) or gas (for downward Tee) entrainment calculation and phase separation

### 255.3.3 Additional variables for 1-D

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
HUWSCHEM	v				Active the 2 <sup>nd</sup> order donor-cell scheme for RCG.
ITDIVER	t				TEE JETPUMP momentum activation flag (if ITDIVER==3608 then enabled else disabled)

### 255.3.4 Variables for coupling with external codes: momentum and energy sources

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
DPGEXT	v				Pure momentum source for the gas phase (Pa)
DPLEXTR	v				Pure momentum source for the liquid phase (Pa)
OVPGEXT	v				To modify the advective term in the gas momentum equation (double). < -1.: advective term = 0 for negative gas velocity > 1.: advective term = 0 for positive gas velocity else : standard CATHARE advective term

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 805/851

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
OVPLEXT	v				To modify the advective term in the liquid momentum equation (double). < -1.: advective term = 0 for negative liquid velocity > 1.: advective term = 0 for positive liquid velocity else : standard CATHARE advective term
OVHGEXT	s				To modify the enthalpy considered in the convective term of the gas energy equation (double). < -1.: upstream enthalpy = ENTHEXT (see below) for negative gas velocity > 1.: upstream enthalpy = ENTHEXT (see below) for positive gas velocity else : standard CATHARE convective term
OVHLEXT	s				To modify the enthalpy considered in the convective term of the liquid energy equation (double). < -1.: upstream enthalpy = ENTHEXT (see below) for negative liquid velocity > 1.: upstream enthalpy = ENTHEXT (see below) for positive liquid velocity else : standard CATHARE convective term
ENTHEXT	s				Enthalpy considered in the convective term of the gas (resp. liquid) energy equation when OVHGEXT (resp. OVHLEXT) is < -1. or > 1. (J/kg)

### 255.3.5 Additional variables for 0-D

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
LEVEL		0			Liquid level in a volume (m)

#### 255.3.5.1 Case of flomixer model

The variable should be written on both volumes.

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
DQMAXI		0			Maximal value of the asymmetry coefficient between incoming flow rates for which the incomplete mixture model can be applied
AGMAXI		0			Maximal value of void fraction for which the incomplete mixture model can be applied

#### 255.3.5.2 Case of VFILM directive use

The variable should be written on both volumes.

NAMEVAR	1-D	0-D	3-D	TEE	DEFINITION
VGMEAN		0			Gas mean velocity used in Nusselt forced and CO-PAIN correlations (using VUSER definition)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	Page 806/851

### 255.3.6 Variables to impose in external boundary conditions BC3 BC4x BC5x and BC5XX

Refer to MODEL directive to check what are the CCV variable available for each model

PEXT	pressure (Pa)
HLIQEXT	enthalpy of liquid (J/kg)
TLIQEXT	liquid temperature (°C)
UNDERSAT	temperature difference: TSAT(P) – TL outside the element (°C)
UNDERSPV	temperature difference: TSAT(PV) – TL outside the element (°C)
HGASEXT	enthalpy of gas (steam + non condensable) (J/kg)
TGASEXT	gas temperature (°C)
OVERHEAT	temperature difference: TG – TSAT(P) outside the element (°C)
OVERHEPV	temperature difference: TG – TSAT(PV) outside the element (°C)
ALFAEXT	void fraction
VLIQEXT	velocity of liquid (m/s)
JLIQEXT	liquid volumetric flux rate (m/s)
QLIQEXT	liquid flowrate (kg/s)
GAMEXT	slip ratio VG/VL
VGASEXT	velocity of gas (m/s)
JGASEXT	gas volumetric flux rate (m/s)
QGASEXT	gas flowrate (kg/s)
QTOTEXT	total flowrate (kg/s)
XEXTi	flow rate of the $i^{th}$ non condensable outside the element (kg/s)
LIQFRXj	activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the $j^{th}$ radio-chemical component in liquid phase outside the element
GASFRXj	activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the $j^{th}$ radio-chemical component in gas phase outside the element

#### Example

DOWNCO is an axial element :

```

iq3 = SCALAR    downco    12.3 ;
ip6 = VECTOR    downco    7.6 ;
WRITE    200.D5  PRESSURE   downco    iq3 ;
WRITE    10.      LIQV       downco    ip6 ;
WRITE    0.51    X1FRACT   downco ;
(only on the scalar point 1)
WRITE    0.51    X1FRACT   downco    10 ;
WRITE    0.51    X1FRACT   downco    -1 ;
( on every scalar point )

```

VOLDOWN is a volume :

```

WRITE    1.        LEVEL      voldown ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 807/851

## 255.4 CCV imposed in an external RUPTURE element

In case of an external RUPTURE defined (see ASSIGN directive)

<b>Syntax</b>
---------------

```
WRITE      xval      NAMEVAR      ruptu      ;
```

<b>NAMEVAR</b>	: name of the variable
<b>ruptu</b>	: name of a RUPTURE element

**Names of the variables which can be written:**

PEXT	: pressure in the containment building (Pa). It corresponds at PFULOPN in the ASSIGN directive.
TGASEXT	: gas temperature in the containment building (°C)
TLIQEXT	: liquid temperature in the containment building (°C)
AGEEXT	: void fraction in the containment building
XEXTi	: mass fraction of the $i^{th}$ non condensable gas in the containment building
TIMERG	: break opening time

<b>Example</b>
----------------

RUPTUR is an external RUPTURE element

```
WRITE      0.9D5      PEXT      RUPTUR ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 808/851

## 255.5 CCVs imposed in a WALL

### Syntax

**WRITE**      xval      **NAMEVAR**      wall1      **(GROUP)**      iaxial      iradial;

**xval** : value to be written (real number)  
**NAMEVAR** : name of the variable  
**wall1** : name of the wall  
If the wall is of type **GROUP**, it must be followed by the keyword GROUP. In that case, the value is written for all the walls of the group.  
**iaxial** : wall axial mesh number.  
**iradial** : wall radial mesh number.

-1 value may always be used to impose the same value upon all the points of the wall.

Name of the variables which can be written :

### 255.5.1 General variables

<b>NAMEVAR</b>	ixial		iradial	<b>Definition</b>
	<b>axial</b> <b>or</b> <b>threed</b>	<b>volume</b>		
WALLWETT	s	m	0	wet wall temperature (°C)
WALLDRYT	s	m	0	dry wall temperature (°C)
WALLTEMP	s	m	r	temperature in a mesh or an axial row of meshes (°C)
WALLALLT	0	0	-1	temperature in all radial and axial meshes (°C)
DEFORMAT	s	0	0	wall external deformation
WSURFEXT	s		0	external exchange surface ( $m^2$ )
IWLLOS	s	m	0	indicator giving the type of external condition 1 : explicit imposed flux is given by Hext*Text (refer to WALL definition or FLUMOD directive or CCV) 2 : explicit imposed flux is given by PHIEXT (refer to WALL definition) or CCV 4 : explicit imposed flux is given by RADEXT (refer to WALL definition) 5 : explicit imposed flux is given by RADEXT and HEXT*TEXT (refer to wall definition) 6 : explicit imposed flux is given by RADEXT and PHIEXT (refer to wall definition)
PHIEXT	s	m	0	loss flux (imposed by CCV or WALL operator) ( $W/m^2$ )
HEXT	s	m	0	external exchange coefficient (imposed by CCV, FLUMOD directive or WALL operator) ( $W/m^2/°C$ )
TEXT	s	m	0	external temperature (imposed by CCV, FLUMOD directive or WALL operator) (°C)

		<i>DEN/DANS/DM2S/STMF/LMES/RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 809/851

NB : Beware that IWLOS has to be changed in coherency with PHIEXT or HEXT and TEXT.

## 255.5.2 Variables for sensitivity parameter

Must be written again by the user in the restart input deck.

PQPT	s	m	0	Wall to fluid global heat transfer sensitivity parameter
PQFDT	s		0	Wall to fluid global heat transfer downstream the quench front sensitivity parameter
P1K2FDT	0	0	0	placeK2 reflood parameter sensitivity parameter
DNBR	s	m	0	Global DNBR sensitivity parameter
P1QPV	s	m	0	Wall to gas heat transfer sensitivity parameter
P1CHF	s	m	0	Critical heat flux sensitivity parameter
PPHBOI	s	m	0	Film-boiling sensitivity parameter in case of no reflooding
PPHBOR	s	m	0	Film-boiling sensitivity parameter in case of reflooding
PPCH	s	m	0	Wall-interface heat transfer sensitivity parameter in case of Chen correlation. PPCH must be equal to PQCH (see WRITE for ELEMENT §1.3).
PPSHER	s	m	0	Wall-interface heat transfer sensitivity parameter in case of Chen correlation with non condensable gas (modification of Sherwood number). PPSHER must be equal to PQSHER (see WRITE for ELEMENT §1.3).
PPHCov	s	m	0	Heat transfer for steam convection sensitivity parameter
PPHCFV	s	m	0	Heat transfer for forced steam convection sensitivity parameter when there is no reflooding
PPHCNV	s	m	0	Heat transfer for natural steam convection sensitivity parameter when there is no reflooding
PPHCFR	s	m	0	Heat transfer for forced steam convection sensitivity parameter in case of reflooding
PPHCNR	s	m	0	Heat transfer for natural steam convection sensitivity parameter in case of reflooding
PPHRDL	s	m	0	Heat transfer for liquid radiation sensitivity parameter
PPHRDV	s	m	0	Heat transfer for steam radiation sensitivity parameter
PCFLL	s	m	0	Wall to fluid heat transfer sensitivity parameter in case of laminar forced convection
PCFLT	s	m	0	Wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection
PCNLL	s	m	0	Wall to fluid heat transfer sensitivity parameter in case of laminar natural convection
PCNLT	s	m	0	Wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection
PCNB	s	m	0	Wall to fluid heat transfer sensitivity parameter in case of nucleate boiling
PQPICF	s	m	0	Wall to liquid heat transfer sensitivity parameter in case of film condensation
PQPVCF	s	m	0	Wall to steam heat transfer sensitivity parameter in case of film condensation
PCVC7	s			Wall to fluid heat transfer sensitivity parameter in case of gas convection for C7 post-CHF heat transfer regime
PBOC7	s			Wall to fluid heat transfer sensitivity parameter in case of film-boiling for C7 post-CHF heat transfer regime

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 810/851</a>

PPGC7	s		Wall to steam radiative transfer sensitivity parameter for C7 post-CHF heat transfer regime
PPLC7	s		Wall to liquid radiative transfer sensitivity parameter for C7 post-CHF heat transfer regime
PCVC9	s		Wall to fluid heat transfer sensitivity parameter in case of gas convection for C9 post-CHF heat transfer regime

#### Characteristics of iaxial and iradial :

s	wall axial mesh number
m	higher sub-volume ⇒ keyword SUP (i.e. 2)lower sub-volume ⇒ keyword INF (i.e. 1)
-1	same value for all meshes
r	radial mesh number
0	nothing

**WARNING :** To define wall axial mesh, never use the directive SCALAR which refers to the hydraulic meshing. Wall axial mesh number must be directly located by the user.

#### Example

par1 belongs to an axial element :

```

iq3 = 7 ;
WRITE      200.        WALLWETT  par1      iq3 ;
WRITE      200.9       WALLTEMP   par1      -1 ;           2 ;
WRITE      200.9       WALLTEMP   par1      iq3 ;           2 ;
WRITE      200.9       WALLALLT  par1      -1 ;
WRITE      200.        FOULING   par1 ; 

WRITE      1           IWLOS     par1      -1;
WRITE      20.D0       HEXT      par1      -1;
WRITE      90.D0       TEXT      par1      -1;

WRITE      2           IWLOS     par1      -1;
WRITE      -1.108D3    PHIEXT   par1      -1;

par2 belongs to a volume :
WRITE      200.        WALLWETT  par2      SUP ;

```

	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 811/851</a>

## 255.6 CCVs imposed in an EXCHANGER

### Syntax

**WRITE**      **xval**      **NAMEVAR**      **exch**      **i axial**      **i radial;**

<b>xval</b>	: value to be written (real number)
<b>NAMEVAR</b>	: name of the variable
<b>exch (or exch1 or exch2)</b>	: exchanger name (for the primary the name must be followed by "1", and for the secondary side by "2") <b>NB</b> : if the exchanger name is 8 characters long, the primary and secondary side names are given replacing the 8 <sup>th</sup> character respectively by 1 or 2
<b>i axial</b>	: wall axial mesh number from the primary side point of view.
<b>i radial</b>	: wall radial mesh number.

-1 value may always be used to impose the same value upon all the points of the wall.

Name of the variables which can be written :

### 255.6.1 General variables

<b>NAMEVAR</b>	<b>i axial</b>	<b>i radial</b>	<b>Definition</b>
EXCHPRIT	s or -1	0	primary side temperature (°C)
EXCHSECT	s or -1	0	secondary side temperature (°C)
EXCHTEMP	s or -1	r	temperature in a mesh or an axial row of meshes (°C)
WALLALLT	0	-1	temperature in all meshes (°C)
FOULING	0	0	fouling factor
DEFORMAT	s	0	wall external deformation
WSURFEXT	s	0	external exchange surface (m <sup>2</sup> )

### 255.6.2 Variables for sensitivity parameter

Must be written again by the user in the restart input deck.

<b>PQPT</b>	s	0	Wall to fluid global heat transfer sensitivity parameter
<b>DNBR</b>	s	0	Global DNBR sensitivity parameter
<b>P1QPV</b>	s	0	Wall to gas heat transfer sensitivity parameter
<b>P1CHF</b>	s	0	Critical heat flux sensitivity parameter
<b>PPHBOI</b>	s	0	Film-boiling sensitivity parameter in case of no reflooding
<b>PPHCOV</b>	s	0	Heat transfer for steam convection sensitivity parameter
<b>PPCH</b>	s	0	Wall-interface heat transfer sensitivity parameter in case of Chen correlation. PPCH must be equal to PQCH (see WRITE for ELEMENT §1.3).
<b>PPSHER</b>	s	0	Wall-interface heat transfer sensitivity parameter in case of Chen correlation with non condensable gas (modification of Sherwood number). PPSHER must be equal to PQSHER (see WRITE for ELEMENT §1.3).

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 812/851

PPHCFV	s	0	Heat transfer for forced steam convection sensitivity parameter when there is no reflooding
PPHCNV	s	0	Heat transfer for natural steam convection sensitivity parameter when there is no reflooding
PPHRDL	s	0	Heat transfer for liquid radiation sensitivity parameter
PPHRDV	s	0	Heat transfer for steam radiation sensitivity parameter
PCFLL	s	0	Wall to fluid heat transfer sensitivity parameter in case of laminar forced convection
PCFLT	s	0	Wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection
PCNLL	s	0	Wall to fluid heat transfer sensitivity parameter in case of laminar natural convection
PCNLT	s	0	Wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection
PCNB	s	0	Wall to fluid heat transfer sensitivity parameter in case of nucleate boiling
PQPICF	s	0	Wall to liquid heat transfer sensitivity parameter in case of film condensation
PQPVCF	s	0	Wall to steam heat transfer sensitivity parameter in case of film condensation

#### Characteristics of iaxial and iradial :

s	wall axial mesh number
-1	same value for all meshes
r	radial mesh number
0	nothing

**WARNING :** To define wall axial mesh, never use the directive SCALAR which refers to the hydraulic meshing. Wall axial mesh number must be directly located by the user.

**WARNING:** the WRITE directive is applied:

1. on the primary side, if the exchanger name is followed by "1" (example: exch1),
2. on the secondary side, if the exchanger name is followed by "2" (example: exch2),
3. on the two sides, if the user only specifies the name of the exchanger (example: exch).

#### Example

```

exch      : name of the exchanger (primary side)
iq3 =    7 ;
WRITE    200.          EXCHPRIT   exch      iq3 ;
WRITE    200.9         EXCHTEMP   exch      iq3      2 ;

```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 813/851

## 255.7 CCVs imposed in a FUEL WALL

### Syntax

**WRITE**      **xval**      **NAMEVAR**      **fuel1**      **(GROUP)**      **iaxial**      **iradial;**

<b>xval</b>	: value to be written
<b>NAMEVAR</b>	: name for the variable
<b>fuel1</b>	: name of the <b>fuelchar</b>
	If the fuel wall is of type <b>GROUP</b> , this element must be followed by the keyword <b>GROUP</b> . In that case, the value are written for all the fuel walls of the group.
<b>iaxial</b>	: scalar axial mesh number
<b>iradial</b>	: radial mesh number

-1 value may always be used to impose the same value upon all the points of the wall.

**Names of the variables which can be written :**

### 255.7.1 General variables

<b>NAMEVAR</b>	<b>Definition</b>	<b>iaxial</b>	<b>iradial</b>
POWNEUT	user external non residual power (W) (if none kinetics model is defined) ( $POWNEUT \geq 0$ if the power is lost by the wall, and $\leq 0$ if the power is received by the wall)	0	0
COEFPNEU	multiplicative coefficient of the non residual power stored in Cathare hydraulic file (only to be used for FUELCHAR with CATAFUEL option)	0	0
DEFORMAT	wall external deformation	s	0
POWLIRE	user external residual lineic power (W) (if none kinetics model is defined)	s	0
WALLWETT	wet wall temperature ( $^{\circ}$ C)	s	0
WALLDRYT	dry wall temperature ( $^{\circ}$ C)	s	0
WALLTEMP	temperature in a mesh or an axial row of meshes ( $^{\circ}$ C)	s	r
INSERT	Control rod group insertion in the core (m)	s	
UO2COND	UO2 pallet conductivity (W/m/K)	0	0
GAPCOND	Gap conductivity (W/m/K)	0	0
CLADCOND	Cladding conductivity (W/m/K)	0	0
OXIICOND	Internal oxide layer conductivity (W/m/K)	0	0
OXIECOND	External oxide layer conductivity (W/m/K)	0	0
FLURADI	External oxide layer conductivity ( $W/m^2$ )	s	

 <p>DE LA RECHERCHE À L'INDUSTRIE cea SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 814/851

## 255.7.2 Variables for sensitivity parameters

Must be written again by the user in the restart input deck.

PQPT	Wall to fluid global heat transfer sensitivity parameter	s	
PQFDT	Wall to fluid global heat transfer downstream the quench front sensitivity parameter	s	
P1K2FD	placeK2 reflooding parameter sensitivity parameter	0	
DNBR	Global DNBR sensitivity parameter	s	
P1QPV	Wall to gas heat transfer sensitivity parameter	s	
P1CHF	Critical heat flux sensitivity parameter	s	
PPHBOI	Film-boiling sensitivity parameter in case of no reflooding	s	
PPHBOR	Film-boiling sensitivity parameter in case of reflooding	s	
PPHCOV	Heat transfer for steam convection sensitivity parameter	s	
PPHCFV	Heat transfer for forced steam convection sensitivity parameter when there is no reflooding	s	
PPHCNV	Heat transfer for natural steam convection sensitivity parameter when there is no reflooding	s	
PPHCFR	Heat transfer for forced steam convection sensitivity parameter in case of reflooding	s	
PPHCNR	Heat transfer for natural steam convection sensitivity parameter in case of reflooding	s	
PPHRDL	Heat transfer for liquid radiation sensitivity parameter	s	
PPHRDV	Heat transfer for steam radiation sensitivity parameter	s	
PCFLL	Wall to fluid heat transfer sensitivity parameter in case of laminar forced convection	s	
PCFLT	Wall to fluid heat transfer sensitivity parameter in case of turbulent forced convection	s	
PCNLL	Wall to fluid heat transfer sensitivity parameter in case of laminar natural convection	s	
PCNLT	Wall to fluid heat transfer sensitivity parameter in case of turbulent natural convection	s	
PCNB	Wall to fluid heat transfer sensitivity parameter in case of nucleate boiling	s	
TCGPGAS1	Pellet/cladding gap He conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS2	Pellet/cladding gap Ar conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS3	Pellet/cladding gap Kr conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS4	Pellet/cladding gap Xe conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS5	Pellet/cladding gap N2 conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS6	Pellet/cladding gap O2 conductivity sensitivity parameter for a COPERNIC fuel wall	s	
TCGPGAS7	Pellet/cladding gap CO2 conductivity sensitivity parameter for a COPERNIC fuel wall	s	
SCFLUQA <sup>1</sup>	Activation energy in $\alpha$ -phase sensitivity parameter	s	
SCFLUQAB <sup>2</sup>	Activation energy in $\alpha\beta$ -phase sensitivity parameter	s	
SCFLUQB <sup>3</sup>	Activation energy in $\beta$ -phase sensitivity parameter	s	

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>	<a href="#">Page 815/851</a>

### Characteristics of iaxial and iradial :

s	wall axial mesh number
-1	same value for all meshes
r	radial mesh number
0	nothing
	not available

## 255.7.3 Accessible variable after GOFUEL directive only for FUELCHAR elements

### 255.7.3.1 General variables

IMODNEUT	value to use to change FUELCHAR power definition. Only for FUELCHAR elements whose power is given by the user (no point kinetics model or hydraulic file stored values). 1000 : power is given by the user through a law (user internal definition). 1002 : power is given by the user through CCV (user external definition).	0	
XNEUMOD	changes the value given to XNEUT in MODXNEUT directive (-1 if not used or already used).	0	
POWXN	changes the value given to the ratio (fission power / fission power + residual power) in MODXNEUT directive (-1 if not used or already used)	0	
Remark	: both POWXN and XNEUMOD values have to be changed to be taken into account. It is similar to use MODXNEUT directive.		
XRESMOD	changes the value given to XRES in MODXRES directive (-1 if not used or already used)	0	
POWXR	changes the value given to the ratio (fission power / fission power + residual power) in MODXRES directive (-1 if not used or already used)	0	
RAYCOLD	cold radius of the pellet. If it is different from 0 this value is used to modify the UO <sub>2</sub> density $\rho = \rho_{ini} * (RAYCOLD^2 / RAY^2)$ with RAY= actual radius of the pellet and $\rho_{ini} = 10950 \text{ kg/m}^3$	0	
ITYPEOX	integer representing the oxidation law to be used for the fuel rod: 1 for Cathcart-Pawell law describing the total oxygen consumption 2 for Baker-Just law 3 for Cathare Cathcart-Pawell law	0	
RELOCDGA	diameter of fuel fragments used to calculate the residual gap	0	
RELOCDCO	diameter of fuel fragments used to calculate the equivalent thermal conductivity	0	

<sup>1</sup>The value specified before this keyword is used in the oxidation equation. It is not a multiplicative coefficient but the value of activation energy in a-phase itself. When this value is equal to zero, the Cathare standard value is used

<sup>2</sup>The value specified before this keyword is used in the oxidation equation. It is not a multiplicative coefficient but the value of activation energy in ab-phase itself. When this value is equal to zero, the Cathare standard value is used.

<sup>3</sup>The value specified before this keyword is used in the oxidation equation. It is not a multiplicative coefficient but the value of activation energy in b-phase itself. When this value is equal to zero, the Cathare standard value is used.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 816/851

RELOCTXO	volume fraction of balloon filled by fuel after relocation	0	
RELOCGAP	value of the gap calculated by relocation model and imposed after the cladding burst at the rupture location	0	
RELOCPWR	value of the power coefficient calculated by relocation model after the cladding burst at the rupture location	0	
GAPCOND	value of the conductivity in the gap	s	
LAMBDUO2	value of UO2 pellet conductivity	s	r
RUPTFRAG	integer value giving the scalar mesh number where the fragile rupture will occur when physical conditions will be fulfilled.	0	

### 255.7.3.2 Sensitivity parameters

Must be written again by the user in the restart input deck)

CTOTLAMB	UO2 conductivity sensitivity parameter	0	
COEFALRU	Sensitivity parameter of the rupture deformation	0	
COEFSTRU	Stress rupture sensitivity parameter	0	
COEFHGAS	Gap conductance sensitivity parameter	0	
COEFEMI	Clad emissive sensitivity parameter	0	
COEFPRES	Residual power sensitivity parameter	0	
COEFROCP	UO2 rCp sensitivity parameter	0	
COEFCP	UO2 heat capacity sensitivity parameter	0	
COEFRHO	UO2 density sensitivity parameter	0	
CLADLAMB	Clad conductivity sensitivity parameter	0	
CLADROCP	Clad rCp sensitivity parameter	0	
COEFLAMB	Pellet conductivity sensitivity parameter	s	
FLUAGE	Creep rate sensitivity parameter	0	
COXLAW	Internal and external oxide layer thickness rate sensitivity parameter	0	
COXNRJ	Internal and external oxide layer volume power sensitivity parameter	0	

 <p>DE LA RECHERCHE À L'INDUSTRIE  <b>cea</b>  SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/  RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 817/851

## 255.8 CCVs imposed in a reflooding sub-module (REFLCHAR/REFLCHAR3D)

No CCV can be imposed.

The CCV defined below and imposed on one wall are transmit to the associated REFLCHAR/REFLCHAR3D element.

CTOTLAMB	: pellet conductivity sensitivity parameter
COEFROCP	: $\rho C_p$ pellet sensitivity parameter
CLADLAMB	: clad conductivity sensitivity parameter
CLADROCP	: clad $\rho C_p$ sensitivity parameter

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 818/851

## 255.9 CCVs imposed in an ACCUMULATOR

### Syntax

**WRITE**      xval      **NAMEVAR**      accu1;

**xval** : value to be written (real number)  
**NAMEVAR** : name of the variable  
**accu1** : name of the ACCU

#### Names of the variables which can be written :

##### 255.9.1 General variables

GASVOL	: accumulator gas volume ( $m^3$ )
LIQMASS	: accumulator water mass (kg)
GASMASS	: accumulator gas mass (kg)
ICLOS	: indicator related to the discharge of the non-condensable gas declared in the ACCU operator. The value 1 (default value) corresponds to the discharge of the non condensable gas after total evacuation of water (see NOCLOSE optional keyword for the ACCU operator). The value 0 corresponds to the closure of the accumulator after total evacuation of water (without discharge of the non condensable gas).
VALCOEFA	: coefficient A of the valve hysteresis model (Pa)

##### 255.9.2 Variables for sensitivity parameters

Must be written again by the user in the restart input deck.

PABTL	: bl sensitivity parameter in case of the injection of an accumulator into a volume. This parameter must be positive. The result of the product $bl \cdot PABTL$ must belong to [0;1]. If the product is greater than 1. bl is imposed equal to 1. and its derivatives are imposed to 0.
PABTG	: bg sensitivity parameter in case of the injection of an accumulator into a volume. This parameter must be positive. The result of the product $bg \cdot PABTG$ must belong to [0;1]. If the product is greater than 1. bg is imposed equal to 1. and its derivatives are imposed to 0.

### Example

**WRITE**      xm1      LIQMASS      accu1 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 819/851

## 255.10 CCVs imposed in a CANDLE

### Syntax

```
WRITE      xval      NAMEVAR    candle1;
```

**xval** : value to be written (real number)  
**NAMEVAR** : name of the variable  
**candle1** : name of the CANDLE of the external type

#### Names of the variables which can be written :

### 255.10.1 Variables for 1-D or 3-D element

LIQPOWER	: Power (W) directly injected into the bulk liquid phase without changing the interface heat flux.
GASPOWER	: Power (W) directly injected into the bulk gas phase without changing the interface heat flux.
INTERLIQ	: Power (W) directly injected into the bulk liquid phase with changing the interface to liquid heat flux.
INTERGAS	: Power (W) directly injected into the bulk gas phase with changing the interface to vapor heat flux.

### 255.10.2 Variables for 0-D element

INJECVOL	: Power (W) injected directly into the bulk dominant phase of the sub-volume addressed by the CANDLE (depending on level and elevation).
----------	--

### Example

```
WRITE      200.      LIQPOWER    candle1 ;  
WRITE      200.      INJECVOL   candle1 ;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 820/851

## 255.11 CCVs imposed in a PIQxxx gadget

### Syntax

```
WRITE      xval      NAMEVAR    piqxx1      ;
```

**xval** : value to be written  
**NAMEVAR** : name of the variable  
**piqxx1** : piqxx name

**WARNING** Some variables can only be written for the external fluid which enters into an element calculated by CATHARE.

**Names of the variables which can be written :**

### 255.11.1 Variables for all PIQxxx gadgets

HLIQEXT	: liquid enthalpy outside the element (J/kg)
HGASEXT	: gas enthalpy outside the element (J/kg)
TLIQEXT	: liquid temperature outside the element (°C)
TGASEXT	: gas temperature outside the element (°C)
ALFAEXT	: void fraction outside the element
XiEXT	: mass fraction of the $i^{th}$ non condensable outside the element
UNDERSAT	: temperature difference: TSAT(P) – TL outside the element (°C)
UNDERSPV	: temperature difference: TSAT(PV) – TL outside the element (°C)
OVERHEAT	: temperature difference: TG – TSAT(P) outside the element (°C)
OVERHEPV	: temperature difference: TG – TSAT(PV) outside the element (°C)

Radio-chemical concentrations/activities : refer to WRIBA but WRITE is faster :

GASFRXj	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the $j^{th}$ radio-chemical component in gas phase outside the element
LIQFRXj	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the $j^{th}$ radio-chemical component in liquid phase outside the element

### 255.11.2 Additional variables for PIQBREK

PEXT	: pressure outside the element (Pa)
TOPEN	: time of gadget opening start
DTOPEN	: time of reach full opening after TOPEN
SECTBREC	: opening ratio of the PIQBREK requested by the user (normalized section of the break) (PU)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 821/851

### 255.11.3 Additional variables for PIQSOUP

PEXT	: pressure outside the element (Pa)	
IFailure	: index of failure type (SIPA Norm) related meaning of XFAILURE	
	0 – no failure (default value) 1 – spurious lift 2 – spurious closure 3 – closing sticking 4 – opening sticking 5 – position sticking 6 – leakage 7 – fouling 9 – derivative of characteristics 11 – spurious lift + fouling 12 – spurious closure + leakage	0 – - 1 – - 2 – - 3 – minimum closing section (%) 4 – maximum opening section (%) 5 – sticking section (%) 6 – leakage rate ( $0 < x < 1$ ) 7 – fouling rate ( $0 < x < 1$ ) 9 – maximum rate of reference pressure drift ( $-1 < x < 1$ ) 11 – fouling rate ( $0 < x < 1$ ) 12 – leakage rate ( $0 < x < 1$ )
XFailure	: failure rate (PU)	

### 255.11.4 Additional variables for PIQSEB

PEXT	: pressure outside the element (Pa)
------	-------------------------------------

And, for each SEBIM included in the PIQSEB :

**WRITE**      xvar      **NAMEVAR**      sebim1      ;

<b>xvar</b>	: value to be written
<b>NAMEVAR</b>	: name of the variable
<b>sebim1</b>	: SEBIM name

NAMEVAR can take the following values:

IFailure	: index of failure type (SIPA Norm) 0 – no failure (default value) 1 – spurious lift 2 – spurious closure 3 – closing sticking 4 – opening sticking 5 – position sticking 6 – leakage 7 – fouling 9 – derivative of characteristics 11 – spurious lift + fouling 12 – spurious closure + leakage	related meaning of XFAILURE 0 – - 1 – - 2 – - 3 – minimum closing section (%) 4 – maximum opening section (%) 5 – sticking section (%) 6 – leakage rate ( $0 < x < 1$ ) 7 – fouling rate ( $0 < x < 1$ ) 9 – maximum rate of reference pressure drift ( $-1 < x < 1$ ) 11 – fouling rate ( $0 < x < 1$ ) 12 – leakage rate ( $0 < x < 1$ )
----------	---	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 822/851

<b>XFAILURE</b> <b>IFORCE</b>	: failure rate (PU) : (only for Cathare/simulator coupling) value is 1 if the type 1 Cathare failure (spurious lift) is also a failure for the simulator, 0 if not	
----------------------------------	--	--

## 255.11.5 Additional variables for PIQVANNE

<b>PEXT</b>	: pressure outside the element (Pa)
<b>ROREF</b>	: specific mass of the fluid under nominal conditions (kg/m <sup>3</sup> ) - 1000 means subsonic liquid type head loss coefficient KV - 1 means sonic vapor type head loss coefficient KV

For each CONTROL VALVE included in the PIQVANNE :

**WRITE**      xvar      **NAMEVAR**      valve1      ;

**xvar**                    : value to be written  
**NAMEVAR**                : name of the variable  
**valve1**                  : VALVE name

NAMEVAR can take the following values:

<b>IFailure</b>	: number of failure type (SIPA Norm) 0 – no failure 6 – leakage 7 – fouling
<b>XFAILURE</b>	: failure rate (PU)
<b>PU</b>	: position of the stem (range : 0 (fully closed) to 1 (fully opened))

For each CHECKVALVE included in the PIQVANNE :

**WRITE**      xvar      **NAMEVAR**      chval      ;

**xvar**                    : value to be written  
**NAMEVAR**                : name of the variable  
**chva1**                  : CHECKVALVE name

NAMEVAR can take the following values:

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 823/851

<b>IFailure</b>  <b>XFailure</b>	: number of failure type (SIPA Norm) 0 – no failure 1 – spurious lift 2 – spurious closure 3 – closing sticking 4 – opening sticking 5 – position sticking 6 – leakage 7 – fouling : failure rate (PU)
--	---

### 255.11.6 Additional variables for PIQREV

<b>TOTFLOW</b> <b>ALFAC</b>	: total flow rate (kg/s) : threshold void fraction to start gas entrainment
--------------------------------	--

For PFM or FVM kinds of PIQREV:

<b>ENTHFLOW</b> <b>XiFLOW</b>	: total enthalpy flow rate (J/s). It replaces any energy specification (HLIQEXT, TLIQEXT, HGASEXT ...) : mass flow rate of the $i^{th}$ noncondensable outside the element (kg/s)
----------------------------------	--

### 255.11.7 Additional variables for PIQARE

<b>ALFAC</b> <b>AREFLOW</b> <b>RATINI</b> <b>CONST</b> <b>SECASP</b>	: threshold void fraction to start gas entrainment : total flow rate (kg/s) : ARE overflow rate during steady state calculation (if different from data deck) (value between 0 and 1) : fitting constant : section to use to evaluate velocity in the steam generator at the injection point for the model ( $m^2$ )
--	--

#### Example

```
PIQBREK :  
WRITE      1.5D5      PEXT      piqbrk1 ;
```

```
PIQSOUPE :  
WRITE      5          IFAILURE   piqsou1 ;  
WRITE      0.2        XFAILURE   piqsou1;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 824/851

PIQSEB :

WRITE        2            IFAILURE        sebim1 ;

PIQVANNE :

WRITE        6            IFAILURE        chval1 ;  
 WRITE        0.5        XFAILURE        chval1 ;

PIQREV :

WRITE        -10.        TOTFLOW        piqrev1 ;

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 825/851

## 255.12 CCVs imposed in a 0D- PUMP

### Syntax

```
WRITE      xval      NAMEVAR    pump1 ;
```

**xval** : value to be written (real number)  
**NAMEVAR** : name of the variable  
**pump1** : name of the PUMPCHAR

#### Names of the variables which can be written

Only if the asynchronous motor model has been defined in the PUMPCHAR element :

### 255.12.1 General variables

INTENSIT	: stator line intensity (A)
FACTPUIS	: $\cos(\Phi)$ power factor
VNOMIN	: supplied voltage (V)
FREQALIM	: nominal supplied frequency (Hz)
VNOMALIM	: nominal supplied voltage (V)
TENSALIM	: electromagnetic pump voltage (V)

### 255.12.2 Variables for failure

IFailure	: Blocked rotor indicator (0 if it is free , 1 if it is blocked) (indicator of BLKROTOR directive use)
XFailure	: Multiplicative coefficient applied to head loss coefficient imposed in case of failure (between 0. and 1.)

### 255.12.3 Variables for sensitivity parameter

Must be written again by the user in the restart input deck.

CGRAVH	: Pump height sensitivity parameter
--------	-------------------------------------

### Example

```
WRITE      I1      INTENSIT    pump1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 826/851

## 255.13 CCVs imposed in a SINK

### Syntax

**WRITE**      xval      **NAMEVAR**      sink1 ;

<b>xval</b>	: value to be written (real number)
<b>NAMEVAR</b>	: name of the variable
<b>sink1</b>	: name of the SINK (SINK EXTERNAL, SINK SAFETYVA, SINKKRI)

### Names of the variables which can be written :

#### 255.13.1 General variables

TOTFLOW	: sink flow rate (kg/s) (should be a negative real value)
IPSIN	: position of the sink (number of a scalar point)

#### 255.13.2 Additional variables for a sink-safety valve

VALVSECT	: full-opening cross-section of the valve ( $m^2$ )
VALSECC	: current cross-section of the valve ( $m^2$ )
VALVPRES	: valve calibration pressure (Pa)

#### 255.13.3 Additional variables for a RRI sink (type SINKRRI)

##### 255.13.3.1 Variables for the Low Pressure Safety Injection (LPSI or ISBP)

FLOWISBP	: liquid flow rate of low pressure safety injection (LPSI/ISBP) (kg/s)
----------	--

##### 255.13.3.2 Variables for the Containment Spray System (EAS)

FLOWEAS	: liquid flow rate of the spray (containment spray system source/ EAS source) (kg/s)
---------	--

##### 255.13.3.3 Variables at the Component Cooling System (RRI)

FLOWRRI	: flow rate ( at RRI/SEC exchanger outlet) (kg/s)
---------	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 827/851

XREAS	: rate of flow rate in EAS/RRI exchanger (value between 0. and 1.) : $Q(\text{EAS/RRI}) / [ Q(\text{EAS/RRI}) + Q(\text{ISBP/RRI}) ]$
FLOWAUX	: additional flow rate extracted from RRI (other than EAS and ISBP) (kg/s)
POWAUX	: additional power extracted from RRI (other than EAS and ISBP) (W)

#### 255.13.3.4 Variables for the Essential Service Water System (SEC)

FLOWSEC	: flow rate in RRI/SEC exchanger (kg/s)
TEMPSECF	: liquid temperature at the RRI/SEC exchanger inlet (°C)

#### 255.13.3.5 Variables for the Raw Water system (SEB)

FLOWSEB	: flow rate in EAS/SEB exchanger (kg/s)
TEMPSEBF	: liquid temperature at the EAS/SEB exchanger inlet (°C)

#### Example

```
WRITE      -200.          TOTFLOW      sink1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 828/851

## 255.14 CCVs imposed in a SOURCE

### Syntax

**WRITE**      **xval**      **NAMEVAR**      **source1** ;

**xval** : value to be written (real number)  
**NAMEVAR** : name of the variable  
**source1** : SOURCE name (SOURCE EXTERNAL, SOURIS)

#### Names of the variables which can be written :

### 255.14.1 General variables

<b>TOTFLOW</b>	: total flow rate of source (kg/s) (should be a positive real value)
<b>LIQFLOW</b>	: liquid flow rate of source (kg/s) (should be a positive real value)
<b>GASFLOW</b>	: gas flow rate of source (kg/s) (should be a positive real value)
<b>ENTHFLOW</b>	: power flow rate of source (J/s) (should be a positive real value)
<b>X1EXT</b>	: mass fraction of first non condensable (should be a positive real value)
<b>X2EXT</b>	: mass fraction of second non condensable (should be a positive real value)
<b>X3EXT</b>	: mass fraction of third non condensable (should be a positive real value)
<b>X4EXT</b>	: mass fraction of fourth non condensable (should be a positive real value)
<b>HЛИQEXT</b>	: liquid enthalpy (J/kg)
<b>HGASEXT</b>	: gas enthalpy (J/kg)
<b>UNDERSAT</b>	: difference between saturation temperature and liquid temperature TSAT(P)-TL (°C)
<b>UNDERSPV</b>	: difference between saturation temperature and liquid temperature TSAT(Pv)-TL (°C)
<b>OVERHEAT</b>	: difference between overheat steam temperature and gas saturation temperature TG-TSAT(P) (°C)
<b>OVERHEPV</b>	: difference between overheat steam temperature and gas saturation temperature TG-TSAT(Pv) (°C)
<b>SLIPRATE</b>	: slip ratio VG/VL
<b>TLIQEXT</b>	: liquid temperature (°C)
<b>TGASEXT</b>	: gas temperature (°C)

### 255.14.2 Variables for sensitivity parameters

Mmust be written again by the user in the restart input deck).

<b>PSBTL</b>	: bl sensitivity parameter in case of the injection of a source into a volume. This parameter must be positive. The result of the product bl*PSBTL must belong to [0;1]. If the product is greater than 1., bl is imposed equal to 1. and its derivatives are imposed to 0.
--------------	---

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 829/851

PSBTG	: bg sensitivity parameter in case of the injection of a source into a volume. This parameter must be positive. The result of the product $bg^*PSBTG$ must belong to [0;1]. If the product is greater than 1., bg is imposed equal to 1. and its derivatives are imposed to 0.
-------	--

Please refer to SOURCE operator injection to obtain more information about which values have to be imposed depending on the kind of injection (two-phase, liquid, steam, PFM, VFM ...).

Radio-chemical concentrations/activities :

LIQFRXi	: activity or concentration (GBq/kg or kg of chemical components / kg of liquid) of the $i^{th}$ radio-chemical component in liquid phase.
GASFRXi	: activity or concentration (GBq/kg or kg of chemical components / kg of gas) of the $i^{th}$ radio-chemical component in gas phase.

#### 255.14.3 Additional variables for a SOURIS source

RESPOWER	: core residual power (W)
CONRATE	: rate of condensation in containment

#### 255.14.4 Variables for security injection characteristics

CTYPRIS	: position of the break
FLOWRISF	: cold leg extra liquid flow rate (kg/s)
FLOWRISC	: hot leg extra liquid flow rate (kg/s)
TLRIS	: temperature of extra water (same in hot and cold legs) (°C)

#### Example

```
WRITE      200.      LIQFLOW      sourc1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 830/851

## 255.15 CCVs imposed in a 0D STEAM GENERATOR

### Syntax

```
WRITE      xval      NAMEVAR    sg1      ;
```

**xval** : value to be written  
**NAMEVAR** : name of the variable  
**sg1** : name of the 0D-steam generator (SGCARACT)

#### Names of variables which can be written :

PRESSURE	: pressure in the SG (secondary side) (Pa)
LIQMASS	: liquid mass in the SG (secondary side) (kg)
STEAMASS	: steam mass in the SG (secondary side) (kg)

### Example

```
WRITE      40851.255      LIQMASS    CARAGV1 ;
WRITE      4675.399      STEAMASS    CARAGV1 ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 831/851

## 255.16 CCVs imposed in a turbo-machine sub-module (TCOMCHAR)

### Syntax

**WRITE**      xval      **NAMEVAR**      compi ;

**xval** : value to be written (real number)

**NAMEVAR** : name of the variable

**compi** : name of the TCOMCHAR

#### Names of the variables which can be written :

INERTIA	: compressor or turbine inertia (kg.m <sup>2</sup> )
NOMV	: nominal rotation speed (rad/s)
NOMFLOW	: nominal volumic flow (m <sup>3</sup> /s)
NOMTORQ	: nominal torque (m <sup>5</sup> /s <sup>2</sup> )
GRAVH	: nominal head (m <sup>2</sup> /s <sup>2</sup> )
EXPANSIO	: coefficient of expansion (Cp/Cv)
TDEF	: reference temperature (°C)
PITREF	: reference pressure expansion rate for a turbine (adimensional)
ETATREF	: reference isentropic efficiency for a turbine
PICREF	: reference pressure expansion rate for a compressor (adimensional)
ETACREF	: reference isentropic efficiency for a compressor

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 832/851

## 255.17 CCVs imposed in a TURBINE

### Syntax

**WRITE**      xval      **NAMEVAR**      turbi ;

**xval** : value to be written (real number)

**NAMEVAR** : name of the variable

**turbi** : name of the TURBINE

#### Names of the variables which can be written :

EFFI	: efficiency of the turbine. It will be used only if you are in efficiency mode. If it is not the case, you will have to use MODPNCST directive.
POWER	: imposed power of the turbine. It will be used only if you are in imposed power mode. If it is not the case, you will have to use the MODPCST directive (W).
GAMMA	: value of the $\gamma$ coefficient (= Cp/Cv).

### Example

**WRITE**      eff      EFFI      turb1 ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 833/851

## 255.18 CCVs imposed in a CONTROL VALVE

### Syntax

**WRITE**      xval      **NAMEVAR**      valve ;

**xval** : value to be written  
**NAMEVAR** : name of the variable  
**valve** : name of the control valve

#### Names of the variable which can be written :

<b>PU</b>	: position of the stem (range : 0 (fully closed) to 1 (fully opened))
<b>IFailure</b>	: number of failure type 0 – no failure 6 – leakage 7 – fouling
<b>XFAILURE</b>	: coefficient of failure ( 0 = xval = 1)
<b>RO</b>	: fluid density under nominal conditions (kg/m <sup>3</sup> )

### Example

```
rvp1 = 0.87;
WRITE rvp1 PU vpi1 ;
```

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		<a href="#">Page 834/851</a>

## 255.19 CCVs imposed in a CHECK VALVE

### Syntax

```
WRITE      xval      NAMEVAR      valve ;
```

**xval** : value to be written  
**NAMEVAR** : name of the variable  
**valve** : name of the check valve

#### Names of the variable which can be written :

IFailure	: number of failure type (SIPA Norm) 0 – no failure 1 – spurious lift 2 – spurious closure 3 – closing sticking 4 – opening sticking 5 – position sticking 6 – leakage 7 – fouling 11 – spurious lift + fouling 12 – spurious closure + leakage
XFailure	: coefficient of failure ( $0 \leq xval \leq 1$ )
RO	: fluid density under nominal conditions ( $\text{kg/m}^3$ )

### Example

```
ifail =    7 ;  
xfail = 0.3D0 ;  
WRITE ifail      IFAILURE      check1      ;  
WRITE xfail      XFAILURE      check1      ;
```

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 835/851

## 255.20 CCVs imposed in a FLOW LIMITER

### Syntax

**WRITE**      xval      **NAMEVAR**      valve ;

**xval**                    : value to be written  
**NAMEVAR**                : name of the variable  
**valve**                    : name of the control valve

#### Names of the variable which can be written :

RO	: fluid density under nominal conditions (kg/m <sup>3</sup> )
----	---

### Example

roref1 =            980. ;  
**WRITE**            roref1      RO            LDG1            ;

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 836/851

## 255.21 CCVs imposed in a neutronic sub-module (CORE)

### Syntax

**WRITE**      xval      **NAMEVAR**      core ;

**xval**                    : value to be written  
**NAMEVAR**                : name of the variable  
**core**                    : name of the core

**Names of the variable which can be written :**

<b>SOURCNEU</b>	: Power increase due to external neutron source (W/s)
-----------------	---

### Example

**WRITE**      10.      SOURCNEU      CORE1      ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 837/851

# 256

## WRITHEAD DIRECTIVE

The **WRITHEAD** directive allows to the user to write a heading in a personal opened file. It is used in the *command block*. It contains the date, the title of the input deck, the label of the version and a list of CUSER character variables (representing values indexes).

The format of the heading is as following :

<b>CDATE</b>	Date field
<b>CTITRE</b>	Title field
<b>CVERS</b>	@(#) QLABEL.f +_V25_3_+ 2.2 10/17/08
	NAME1 NAME4 NAME3 NAME2 NAME5 NAME4

Where **CDATE**, **CTITRE**, **CVERS** are fixed keyword (used to reference the file). These fields are automatically filled in the personal file.

The list of CUSER variables “NAMEi” have to be put in CUSER common.

**Warning :** the personal file can not be a Cathare file.

### Associated Keywords

INTERP, OPENFILE, READHEAD, READVAR, REWIND, WRITVAR

### Syntax

```
WRITHEAD nunite      CUSER          SEGMENT       ideb        ifin
                  or           LIST          i1          ...
;               ;           ;           ...         in
```

**nunite** : user variable defined as an integer in the *executive block* and affected thanks to OPENFILE directive.

**SEGMENT** ideb ifin or : keyword followed by the integer values of the first and last CUSER indexes (limited to 10 in case of a FORMATTED file).

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 838/851

**LIST i<sub>1</sub> ... i<sub>n</sub>** : keyword followed by the integer values of CUSER indexes (limited to 10 in case of FORMATTED file).

#### Example

```

WRITE      'P1'          CUSER      1 ;
WRITE      'P2'          CUSER      2 ;
WRITE      'P3'          CUSER      3 ;
WRITHEAD  NUNITE1     CUSER      SEGMENT    1           3 ;
WRITHEAD  NUNITE2     CUSER      LIST       1 3 5 6 ;

```

**N.B** : the FORTRAN subroutine called in PILOT is WRITHEAD :  
 CALL WRITHEAD ( NUNITE, MODLIST, NBLIST, IVAL, IVSTAT)

<b>NUNITE</b>	INTEGER : Fortran unit number
<b>MODLIST</b>	CHARACTER*8 : 'SEGMENT' or 'LIST'
<b>NBLIST</b>	INTEGER : number of CUSER indexes
<b>IVAL</b>	Array of INTEGER (NBLIST) : indexes of CUSER
<b>IVSTAT</b>	Returned error code

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 839/851

# 257

## WRITVAR DIRECTIVE

The **WRITVAR** directive allows to the user to write variables in a personal opened file. It is used in the *command block*.

**Warning :** the personal file can not be a CATHARE file.

### Associated Keywords

INTERP, OPENFILE, READHEAD, READVAR, REWIND, WRITHEAD

### Syntax

<b>WRITVAR</b>	nunite	<b>XUSER</b>	<b>SEGMENT</b>	ideb	ifin	
		or	<b>LIST</b>	i <sub>1</sub>	...	i <sub>n</sub>
	;					

<b>nunite</b>	: user variable defined as an integer in the <i>executive block</i> giving the Fortran unit number of the desired file (given by OPENFILE operator).
<b>SEGMENT</b> ideb ifin	: keyword followed by the integer values of the first and last XUSER indexes (limited to 10 in case of a FORMATTED file).
<b>LIST</b> i <sub>1</sub>	: keyword followed by the integer values of XUSER indexes (limited to 10 in case of FORMATTED file).
... i <sub>n</sub>	

### Example

```

WRITE      100.      XUSER      1;
WRITE      200.      XUSER      2 ;
WRITE      300.      XUSER      3 ;
WRITVAR    NUNITE1   XUSER      SEGMENT    1          3 ;
WRITVAR    NUNITE2   XUSER      LIST 1 3 5 6;
```

		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 840/851

**N.B.** : the FORTRAN subroutine called in PILOT is WRITVAR :  
CALL WRITVAR ( NUNITE, MODLIST, NBLIST, IVAL, IVSTAT)

NUNITE	INTEGER : Fortran unit number
MODLIST	CHARACTER*8 : 'SEGMENT' or 'LIST'
NBLIST	INTEGER : number of XUSER indexes
IVAL	Array of INTEGER (NBLIST) : indexes of XUSER
IVSTAT	Returned error code

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 841/851

258

## XAXIS OPERATOR

The **XAXIS operator**, in *data block*, creates a point by assigning a curvilinear x-coordinate to it. When these points are used in a mesh, they correspond to vector points.

### Associated Keywords

SEGMENT, VECTOR, SCALAR

### Syntax

p1 =                   **XAXIS**                   z ;

**p1**                   : point  
**z**                   : real number ; x-coordinate of the point (m).

### Example

q1 =                   **XAXIS**                   0. ;  
q3 =                   **XAXIS**                   10. ;

**N.B.** : When these points are placed in a mesh with operator SEGMENT, they correspond to vector points. The name of an XAXIS point should not be used again to define another XAXIS point.

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <hr/> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 842/851

259

## XNEULIST AND XNEULISX DIRECTIVES

These two directives are used to introduce a repartition coefficient for the neutronic power, which is variable among the axial coordinate. The **XNEULIST** directive is used in the *data block*, after the **INTEGRATE** directive or after the fuelchar assembly, to define a table of values. The **XNEULISX** directive is used in the *command block*, before transient computation, in order to activate or deactivate the table of values for the repartition coefficient *xneut*.

### Associated Keywords

**FUELCHAR, FUELPLAQ**

### Syntax

<b>XNEULIST</b>	fuelchar1	<b>SIGNAL</b>	p	
signal_1	R11	R12	R13	...
signal_2	R21	R22	R23	...
signal_p	Rp1	Rp2	Rp3	...
				Rpn ;

<b>XNEULISX</b>	fuelchar1	<b>SIGNAL</b>	s1 ;
-----------------	-----------	---------------	------

**fuelchar1** : name of the fuelchar for which the axial evolution must be applied.

**SIGNAL p** : keyword followed by a positive integer and representing the number of signal values.  
**signal\_i (i=1, ..., p)** : list of the signal values. These are real numbers, sorted from the lower to the higher value from i = 1 to p. If this condition is not respected, it provokes a fatal error message.

**Rij (i=1, ..., p), (j=1, ..., n)** : list of values of the repartition coefficient for the neutronic power, for each value i of the signal and for each cell j of the fuelchar. Real numbers > 0.

**NB** : n = nwz is equal to the number of cells of the fuelchar or fuelplaq element.

**s1** : value chosen for the signal, which must be included in the range of values going from signal\_1 to signal\_p defined above.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 843/851

**NB :** If this value is equal to one of the signals entered in the **XNEULIST** table, the profile used is the one corresponding to this signal. Else, the profile used is an interpolation between the two profiles corresponding to the signal values, which border s1.  
The value s1 = -999 is a particular value which deactivates the directive : come back, for each cell, to the initial value defined by the operator FUELCHAR.  
If the value s1 is not included in the range of [signal\_1 ... signal\_p], a fatal error will occur.

### Example

*Data block :*

```
XNEULIST      CARCB      SIGNAL      3
0. 0.01 0.09 0.1 0.15 0.21 0.28 0.35 0.39 0.45 0.52 0.59 0.68 0.71 0.85 0.92 1.0
0.5 0.02 0.1 0.15 0.20 0.25 0.3 0.34 0.42 0.48 0.56 0.65 0.75 0.78 0.89 0.98 1.0
1. 0.05 0.15 0.17 0.25 0.3 0.36 0.47 0.58 0.6 0.65 0.7 0.78 0.85 0.91 0.96 1.0 ;
```

*Command block :*

One can watch a specific value (for example the maximum value of void fraction along the fuel wall) to adjust XNEUT value.

```
ALPHAMAX= VALUE      COAGMAX      CARCB ;
XNEULISX   CARCB      SIGNAL       ALPHAMAX  ;
```

**NB :** The corresponding FORTRAN subroutine (to XNEULISX) called in PILOT is XNEULISX. The arguments are the following ones : CALL XNEULISX ( OBJNAM, RVAL, \*9999)

<b>OBJNAM</b>	CHARACTER*8 name of the fuelchar where the values for the repartition coefficient for the neutronic power must be introduced
<b>RVAL</b>	DOUBLE PRECISION chosen value for the signal

 DE LA RECHERCHE À L'INDUSTRIE		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
<b>Document technique DEN</b>		Page 844/851

260

## XRESLIST AND XRESLISX DIRECTIVES

These two directives are used to introduce a repartition coefficient for the residual power, which is variable among the axial coordinate. The **XRESLIST** directive is used in the *data block*, after the **INTEGRATE** directive or after the fuelchar assembly, to define a table of values. The **XRESLISX** directive is used in the *command block*, during transient computation, in order to modify the table of values for the repartition coefficient XRES.

### Associated Keywords

FUELCHAR, FUELPLAQ, MODXRES

### Syntax

<b>XRESLIST</b>	fuel1	<b>SIGNAL</b>	p	
signal_1	R11	R12	R13	...
signal_2	R21	R22	R23	...
signal_p	Rp1	Rp2	Rp3	...
				Rpn ;

<b>XRESLISX</b>	fuel1	<b>SIGNAL</b>	s1 ;
-----------------	-------	---------------	------

**fuel1** : name of the fuelchar or fuelplaq for which the axial evolution must be applied.

**SIGNAL p** : keyword followed by a positive integer and representing the number of signal values.

**signal\_i (i=1, ..., p)** : list of the signal values. These are real numbers, sorted from the lower to the higher value from i = 1 to p. If this condition is not respected, it provokes a fatal error message.

**Rij (i=1, ..., p), (j=1, ..., n)** : list of values of the repartition coefficient for the residual power, for each value i of the signal and for each cell j of the fuelchar. Real numbers > 0.

**NB :** n = nwz is equal to the number of cells of the fuelchar or fuelplaq element.

**s1** : value chosen for the signal, which must be included in the range of values going from signal\_1 to signal\_p defined above.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 845/851

**NB :** If this value is equal to one of the signals entered in the **XRESLIST** table, the profile used is the one corresponding to this signal. Else, the profile used is an interpolation between the two profiles corresponding to the signal values, which border s1.

The value  $s1 = -999$  is a particular value which deactivates the directive : come back, for each cell, to the initial value defined by the operator FUELCHAR or FUELPLAQ. If the value  $s1$  is not included in the range of [signal\_1 ... signal\_p], a fatal error will occur.

### Example

*Data block :*

```
XRESLIST      CARCB      SIGNAL      3
0. 0.01 0.09 0.1 0.15 0.21 0.28 0.35 0.39 0.45 0.52 0.59 0.68 0.71 0.85 0.92 1.0
0.5 0.02 0.1 0.15 0.20 0.25 0.3 0.34 0.42 0.48 0.56 0.65 0.75 0.78 0.89 0.98 1.0
1. 0.05 0.15 0.17 0.25 0.3 0.36 0.47 0.58 0.6 0.65 0.7 0.78 0.85 0.91 0.96 1.0 ;
```

*Command block :*

One can watch a specific value (for example the maximum value of void fraction along the fuel wall) to adjust XRES value.

```
ALPHAMAX= VALUE      COAGMAX      CARCB ;
XRESLISX     CARCB      SIGNAL      ALPHAMAX    ;
```

**NB :** The corresponding FORTRAN subroutine (to XRESLISX) called in PILOT is XRESLISX. The arguments are the following ones : CALL XRESLISX ( OBJNAM, RVAL, \*9999)

<b>OBJNAM</b>	CHARACTER*8 name of the fuelchar or fuelplaq where the values for the repartition coefficient for the residual power must be introduced
<b>RVAL</b>	DOUBLE PRECISION chosen value for the signal

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 846/851

# 261

## ZONBAMOY DIRECTIVE

The **ZONBAMOY** directive defines the zone giving the reference concentration used to manage the activity of radio-chemical components. This operator must be used in the *data block*.

### Associated Keywords

ACTEMIS, SCRAM, WRIBA, VALBA, RADCHEMI, WCIRCBA, ACCU, INIBORA, GOBORA, ZONBAMOY

### Syntax

**ZONBAMOY** circ1              zone1 ;

**circ1**                            : name of the circuit including the zone.  
**zone1**                            : name of the chosen “reference” zone. At the emergency shutdown and for a specified radio-chemical component (see directive INIBORA), the emission peak is conditioned by the reach of a threshold which is the average concentration of the component in this zone.

### Example

ZONBAMOY CIRCPREM        ZONECORE        ;

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 847/851

# 262

## ZONE OPERATOR

The **ZONE** operator defines a zone from a list of components. This operator must be used in the *data block*.

### Associated Keywords

BILAN3D, INIBIL

### Syntax

```
zone1=      ZONE      elem1      elem2      (GROUP)      elem3...      elemn ;
```

**zone1** : Name of the zone to be defined.  
**elem1** : The zone is a set of elements which all belong to a same circuit.  
**...elemn** If an element is of type **GROUP**, this element must be followed by the keyword **GROUP**. In that case, all the elements of the group belong to the zone.

- During the calculation, the printouts of the zone balance checking (fluid mass and energy, non-condensable gas mass, wall energy and radio-chemical component concentration) will be performed with the frequency defined by the directive PERIOD.
- The post-processing storage is performed with the frequency defined by the directive RESULT.
- The tees, the boundary conditions, and the ruptures are not allowed in the list of the elements of a zone.
- The number of elements declared in a zone must not exceed 60.
- The number of zones declared in the data block must not exceed 10.

### Example

```
zone1 =      ZONE      pipe1      volume1      volume2      threed1      pipe2 ;  
zone2 =      ZONE      pipe1      pipe2      GROUP       pipe3      threed1 ;
```

We assume that the pipe2 is an **AXIAL GROUP** element.

 <p>DE LA RECHERCHE À L'INDUSTRIE <b>cea</b> SACLAY</p>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 848/851

## BIBLIOGRAPHY

- [1] CSSI. CATHARE 2 V2.5\_3 mod2.1 code : Dictionary of the post-processing. Technical Report STMF/LMES/12-039, CEA, 2012.
- [2] CSSI. CATHARE 2 V2.5\_3 mod2.1 code and GUTHARE V1.7.3 GUI : Installation manual. Technical Report STMF/LMES/12-041, CEA, 2012.

 <b>Document technique DEN</b>	<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	Page 849/851

## NOTATIONS

*G* : relative to the gas. [32](#), [371](#), [375](#), [504](#), [509](#), [510](#), [561](#), [584](#), [586](#), [590](#), [592](#), [655](#), [750](#)

*k* : relative to the *k<sup>th</sup>* phase. [394](#), [395](#), [561](#), [564](#), [849](#)

*L* : relative to the liquid. [32](#), [67](#), [123](#), [230](#), [371](#), [372](#), [374](#), [501](#), [504](#), [509](#), [561](#), [584](#), [586](#), [590](#), [591](#), [655](#), [750](#)

*sat* : relative to the saturation conditions. [371](#), [374](#), [375](#), [501](#), [504](#), [509](#), [510](#), [512](#), [514](#), [584](#), [590–592](#)

*sing* : relative to singularities mesh. [561](#), [564](#)

*V* : relative to the steam. [371](#), [372](#), [374](#), [375](#), [501](#), [504](#), [509](#), [510](#), [584](#), [590–592](#)

*W* : relative to the wall. [338](#)

*C* : Pump torque (m). [452](#)

*Cp* : Calorific capacity at constant pressure (J.kg<sup>-1</sup>.K<sup>-1</sup>). [338](#), [394](#), [664](#), [715](#), [716](#), [817](#), [849](#)

*Cv* : Calorific capacity at constant volume (J.kg<sup>-1</sup>.K<sup>-1</sup>). [664](#), [849](#)

*D<sub>h</sub>* : Hydraulic diameter (m). [849](#)

*K* : friction coefficient. [561](#), [564](#)

*H* : Pump head (m). [452](#)

*H* : Enthalpy (J.K<sup>-1</sup>). [32](#), [750](#)

*Nu* : NUSSELT number  $\left[ \frac{h \cdot D_h}{\lambda_k} \right]$ . [98](#)

*Pr* : PRANDL number  $\left[ \frac{v_k \cdot C_{pk}}{\lambda_k} \right]$ . [98](#)

*P* : Pressure (Pa). [32](#), [371](#), [374](#), [375](#), [501](#), [504](#), [509](#), [510](#), [514](#), [561](#), [563](#), [564](#), [584](#), [590–592](#), [750](#)

*q<sub>pg</sub>* : Wall to gas heat flux (W.m<sup>-2</sup>). [406](#)

*Re* : REYNOLDS number  $\left[ \frac{\rho_k \cdot V_k \cdot D_h}{\mu_k} \right]$ . [98](#), [99](#)

*T* : Temperature (°C). [32](#), [122](#), [123](#), [224–229](#), [338](#), [371](#), [374](#), [375](#), [394](#), [395](#), [501](#), [504](#), [509](#), [510](#), [512](#), [514](#), [584](#), [590–592](#)

*V* : Velocity (m.s<sup>-1</sup>). [372](#), [561](#), [564](#), [586](#), [655](#), [750](#), [849](#)

*Z* : altitude-cote (m). [750](#)

*α* : Void fraction. [561](#), [564](#), [750](#), [814](#)

*γ* : Gas isentropic expansion factor  $\frac{C_p}{C_v}$ . [664](#)

*λ* : Conductivity (W.m<sup>-1</sup>.K<sup>-1</sup>). [338](#), [395](#), [849](#)

*μ* : Dynamic viscosity (kg.m<sup>-1</sup>.s<sup>-1</sup>). [395](#), [849](#)

*v* : Cinematic viscosity (m<sup>2</sup>.s<sup>-1</sup>). [849](#)

*ρ* : Density (kg.m<sup>-3</sup>). [67](#), [122](#), [123](#), [224–230](#), [338](#), [561](#), [564](#), [714–716](#), [817](#), [849](#)

 <b>DE LA RECHERCHE À L'INDUSTRIE</b> <b>cea</b> <b>SACLAY</b>		<i>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</i>
	<b>Document technique DEN</b>	Page 850/851

## ACRONYMS

**CCV** : **CATHARE** Computational Variables (VCC). [45](#), [70](#), [137](#), [161](#), [543](#), [558](#), [573](#), [574](#), [576](#), [586](#), [598](#), [667](#), [670](#), [671](#), [686](#), [797](#)

**COMETE** : CATHARE application for rocket motors and engines. [293](#), [303](#), [446](#), [447](#), [463](#), [469](#), [471](#), [654](#), [764](#), [769](#)

**LBB** : Leak-Before-Break. [252](#), [253](#)

**PFM** : Separation before mixture. [435](#)–[437](#), [591](#), [599](#)

**VFM** : Mixture before separation. [435](#)–[437](#), [591](#), [599](#)

**CSS (EAS)** : Containment Spray System (EAS). [576](#)–[580](#)

**LOCA** : Loss Of Coolant Accident. [162](#), [598](#)

**LPSI** : Low Pressure Safety Injection. [576](#)–[578](#)

**NPSH** : Net Positive Section Head of pump. [471](#)

**PEM** : Electro Magnetic Pump. [466](#), [468](#)

**RHR (RRA)** : Reactor Heat Removal system. [421](#), [422](#)

**SIS (RIS)** : Safety Injection System. [598](#)

**CCCW (RRI)** : Component cooling water system (RRI). [576](#)–[579](#)

**ESWS (SEC)** : Essential Service Water System (SEC). [576](#), [578](#), [579](#)

**SGTR** : Steam Generator tube Rupture. [128](#), [137](#), [160](#), [554](#)

**BWR** : Boiling Water Reactor. [380](#), [381](#), [664](#)

**FNR** : Fast Neutron Reactor. [119](#)–[121](#), [123](#), [125](#), [214](#), [219](#), [222](#), [224](#)–[229](#), [234](#)–[236](#), [239](#), [249](#)

**HTR** : High Temperature Reactor. [119](#)–[121](#), [125](#), [214](#), [217](#), [224](#)–[227](#), [230](#), [231](#), [234](#)–[239](#), [248](#)

**NP** : Nuclear propulsion (navy). [223](#), [295](#), [296](#), [774](#)

**PWR** : Pressurized Water Reactor. [119](#)–[122](#), [124](#), [162](#), [214](#), [224](#), [236](#), [237](#), [245](#)

**RJH** : Jules Horowitz reactor. [214](#), [223](#), [295](#), [296](#), [771](#), [774](#)

**UO<sub>2</sub>** : Uranium pellet component. [122](#), [184](#), [186](#), [187](#), [191](#), [197](#), [198](#), [205](#), [207](#), [208](#), [224](#), [451](#), [481](#), [513](#), [533](#), [534](#)

**(U,Pu)O<sub>2</sub>** : Mixed oxide pellet component. [187](#), [205](#), [208](#)

<p>DE LA RECHERCHE À L'INDUSTRIE</p>  <p>cea SACLAY</p>		<p>DEN/DANS/DM2S/STMF/LMES/ RT/I2-040/A</p>
	<p><b>Document technique DEN</b></p>	<p>Page 851/851</p>

**END OF DOCUMENT**