

Appendix B

Detailed Structure of the Matrix A_s

MATSTAB uses vectors to store thermal-hydraulic or neutronic properties. Each entry in a given vector represents the property in a corresponding node. Vectors that contain thermal-hydraulic properties are larger than vectors that contain neutronic properties since the nodes outside of the core are also included. The total number of nodes is dependent on the size of the reactor and on the number of nodes used to describe the outer part of the core (e.g. steam dome, downcomer, etc.). The number of nodes outside the core are chosen as explained in Figure 3.4. For the sake of simplicity real numbers for the Leibstadt NPP with half core case symmetry are used. The GE-6 reactor of Leibstadt uses 648 fuel assemblies. The channels are numbered according to Table B.1.

1	2	3	4	5	6	7	8	9	10	11	12	13	...	30
31	32	33	34	35	36	37	38	39	40	41	42	43	...	60
61	62	63	64	65	66	67	68	69	70	71	72	73	...	90
	91	92	93	94	95	96	97	98	99	100	101	102	...	118
	119	120	121	122	123	124	125	126	127	128	129	130	...	146
		147	148	149	150	151	152	153	154	155	156	157	...	172
			173	174	175	176	177	178	179	180	181	182	...	196
			197	198	199	200	201	202	203	204	205	206	...	220
				221	222	223	224	225	226	227	228	229	...	242
					243	244	245	246	247	248	249	250	...	262
						263	264	265	266	267	268	269	...	280
							281	282	283	284	285	286	...	296
								297	298	299	300	...	308	
									309	310	311	...	318	
											319	...	324	

Table B.1: MATSTAB Numbering Scheme for the Channels in a Half-Core Case

Table B.2 and B.3 describe the structure and numbering scheme for neutronic as well as thermal-hydraulics vectors.

Section	First Node	Last Node	Number of Nodes
Node 1-25 of Channel 1	1	25	25
Node 1-25 of Channel 2	26	50	25
...			
Node 1-25 of Channel 324	8076	8100	25

Table B.2: MATSTAB Numbering Scheme for the Neutronic Representation of the Core

Section	First Node	Last Node	Number of Nodes
Steam Dome	1	1	1
Entry Node DC 1	2	2	1
Downcomer 1	3	8	6
Entry Node DC 2	9	9	1
Downcomer 2	10	15	6
Entry Node LP 1	16	16	1
Lower Plenum 1	17	18	2
Entry Node LP 2	19	19	1
Lower Plenum 2	20	22	3
Entry Nodes CH 1-324	23	346	324
Entry Node Bypass	347	347	1
Node 1 CH 1-324	348	671	324
Node 1 Bypass	672	672	1
Node 2 CH 1-324	673	996	324
Node 2 Bypass	997	997	1
...			
Node 25 CH 1-324	8148	8471	324
Node 25 Bypass	8472	8472	1
Entry Node Riser	8473	8473	1
Riser	8474	8478	5

Table B.3: MATSTAB Numbering Scheme for the Thermal-Hydraulic Representation of the Reactor

Besides the structure of the vectors, it is also necessary to know how many thermal-hydraulic and neutronic state variables are foreseen to be implemented. The quantity of these variables defines the number of equations used in each node. The matrix was originally designed for 13 thermal-hydraulic and 12 neutronic variables. Even though some of these variables are no longer necessary, the matrix structure was never changed. During the construction phase of the matrix, the corresponding rows and columns are filled with zeros. During the iterative solution phase however, the empty rows and columns are omitted. In addition to the 13 times 8478 and 12 times 8100 equations there is one equation for the system pressure, two equations for the pump dynamics and 325 equations for the distribution of the core

flow into 324 channels an the bypass. This adds up to $13 \times 8478 + 12 \times 8100 + 1 + 2 + 325 = 207742$ equations.

Table B.4 shows the ordering of the equations in the matrix A_s .

Section	First Row	Last Row	Number of Rows
TH Section			
System Pressure	1	1	1
Steam Dome	2	14	13
Entry Node DC 1	15	27	13
Downcomer 1	28	105	78
Entry Node DC 2	106	118	13
Downcomer 2	119	196	78
Entry Node LP 1	197	209	13
Lower Plenum 1	210	235	26
Entry Node LP 2	236	248	13
Lower Plenum 2	249	287	39
Entry Nodes CH 1-324	288	4499	4212
Entry Node Bypass	4500	4512	13
Node 1 CH 1-324	4513	8724	4212
Node 1 Bypass	8725	8737	13
Node 2 CH 1-324	8738	12945	4212
Node 2 Bypass	12946	12958	13
...			
Node 25 CH 1-324	105913	110124	4212
Node 25 Bypass	110125	110137	13
Entry Node Riser	110138	110150	13
Riser	110151	110215	65
Flow Distribution Model Core	110216	110539	324
Flow Distribution Model Bypass	110540	110540	1
Pump (driving flow)	110541	110541	1
Pump (pressure drop)	110542	110542	1
Neutronic Section			
Node 1-25 of Channel 1	110543	110842	300
Node 1-25 of Channel 2	110843	111142	300
...			
Node 1-25 of Channel 324	207443	207742	300

Table B.4: MATSTAB Numbering Scheme in the Matrix A_s for the Leibstadt Reactor

Section	First Row	Last Row	Number of Rows
TH Section			
System Pressure	1	1	1
Steam Dome	2	14	13
Entry Node DC 1	15	27	13
Downcomer 1	28	79	52
Entry Node DC 2	80	92	13
Downcomer 2	93	196	104
Entry Node LP 1	197	209	13
Lower Plenum 1	210	235	26
Entry Node LP 2	236	248	13
Lower Plenum 2	249	313	65
Entry Nodes CH 1-338	314	4707	4394
Entry Node Bypass	4708	4720	13
Node 1 CH 1-338	4721	9114	4394
Node 1 Bypass	9115	9127	13
Node 2 CH 1-338	9128	13521	4394
Node 2 Bypass	13522	13534	13
...			
Node 25 CH 1-338	110489	114882	4394
Node 25 Bypass	114883	114895	13
Entry Node Riser	114896	114908	13
Riser	114909	114960	52
Flow Distribution Model Core	114961	115298	338
Flow Distribution Model Bypass	115299	115299	1
Pump (driving flow)	115300	115300	1
Pump (pressure drop)	115301	115301	1
Neutronic Section			
Node 1-25 of Channel 1	115302	115601	300
Node 1-25 of Channel 2	115602	115901	300
...			
Node 1-25 of Channel 338	216402	216701	300

Table B.5: MATSTAB Numbering Scheme in the Matrix A_S for Forsmark 1 and 2

Section	First Row	Last Row	Number of Rows
TH Section			
System Pressure	1	1	1
Steam Dome	2	14	13
Entry Node DC 1	15	27	13
Downcomer 1	28	66	39
Entry Node DC 2	67	79	13
Downcomer 2	80	144	65
Entry Node LP 1	145	157	13
Lower Plenum 1	258	183	26
Entry Node LP 2	184	196	13
Lower Plenum 2	197	222	26
Entry Nodes CH 1-350	223	4772	4550
Entry Node Bypass	4773	4785	13
Node 1 CH 1-350	4786	9335	4550
Node 1 Bypass	9336	9348	13
Node 2 CH 1-350	9349	13898	4550
Node 2 Bypass	13899	13911	13
...			
Node 25 CH 1-350	114298	118847	4550
Node 25 Bypass	118848	118860	13
Entry Node Riser	118861	118873	13
Riser	118878	118925	52
Flow Distribution Model Core	118926	119275	350
Flow Distribution Model Bypass	119276	119276	1
Pump (driving flow)	119277	119277	1
Pump (pressure drop)	119278	119278	1
Neutronic Section			
Node 1-25 of Channel 1	119279	119578	300
Node 1-25 of Channel 2	119579	119878	300
...			
Node 1-25 of Channel 350	223979	224278	300

Table B.6: MATSTAB Numbering Scheme in the Matrix A_s for Forsmark 3

