

APPENDICE C.4.1-1
ALBERI DI GUASTO PER I TOP EVENT

ASTRA - PMX

**Advanced Software Tool for Reliability
Analysis**

FTA Report

Summary Data

General data

Project folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Project name:	NOF
Project version:	N/A
Tree name:	Roll over 1
Tree description:	Mancato ricircolo GNL
Number of basic events:	8
Number of gates:	6
Number of good boundary conditions:	0
Number of failed boundary conditions:	0
Logical cut-off:	10
Probabilistic cut-off:	1.000000E-12
Mission time (hours):	8.760000E+03
Truncation error estimate:	Yes
Type of probabilistic analysis:	ENF - Expected number of failures
Report folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Report file name:	Roll over 1.rtf

Probabilistic Analysis results

Number of minimal cut-sets:	7
Maximum order of minimal cut-sets:	3
Unavailability of TOP event:	5.309931E-08
Expected number of Failures of TOP event:	5.478866E-05
Truncation error:	0.000000E+00
Analysis date (DD/MM/YYYY):	23/03/2016
Analysis time (HH:MM:SS):	16:02:39

Tree Structure

Gate name	Op.	Sons			Description
TOP	OR	G100	G101		Mancato ricircolo GNL
G100	INH	G110	G111		Blocco pompe
G101	INH	S-SDV	G120		Blocco valvola
G110	2/3	P1	P2	P3	Guasto delle pompe 2oo3
G111	OR	ABP	MIO		Protezione pompe
G120	AND	C-SDV	MIO1		Protezione valvola

Primary Events Input Data

Event Name	Failure rate	Repair Time	On-demand unavailability	Test interval	Description
ABP			2.150000E-02		Mancato allarme blocco pompa
C-SDV			2.150000E-02		Mancato allarme chiusura SDV
MIO			1.000000E-03		Mancato intervento operatore
MIO1			1.000000E-03		Mancato intervento operatore
P1	5.220000E-05	1.700000E+01			Guasto pompa 020.P.01 A
P2	5.220000E-05	1.700000E+01			Guasto pompa 020.P.01 B
P3	5.220000E-05	1.700000E+01			Guasto pompa 020.P.01 C
S-SDV	3.000000E-07	5.999999E+00			Chiusura Spuria SDV

Cross Reference Map of Events

Event Name	Parent Gates	Description
ABP	G111	Mancato allarme blocco pompa
C-SDV	G120	Mancato allarme chiusura SDV
MIO	G111	Mancato intervento operatore
MIO1	G120	Mancato intervento operatore
P1	G110	Guasto pompa 020.P.01 A
P2	G110	Guasto pompa 020.P.01 B
P3	G110	Guasto pompa 020.P.01 C
S-SDV	G101	Chiusura Spuria SDV

Cross Reference Map of Gates

Gate Name	Parent Gates	Description
G100	TOP	Blocco pompe
G101	TOP	Blocco valvola
G110	G100	Guasto delle pompe 2oo3
G111	G100	Protezione pompe
G120	G101	Protezione valvola
TOP		Mancato ricircolo GNL

Events Unavailability

Event Name	Unavailability	Description
ABP	2.150000E-02	Mancato allarme blocco pompa
C-SDV	2.150000E-02	Mancato allarme chiusura SDV
MIO	1.000000E-03	Mancato intervento operatore
MIO1	1.000000E-03	Mancato intervento operatore
P1	8.866132E-04	Guasto pompa 020.P.01 A
P2	8.866132E-04	Guasto pompa 020.P.01 B
P3	8.866132E-04	Guasto pompa 020.P.01 C
S-SDV	1.799996E-06	Chiusura Spuria SDV

Events Importance

Event Name	Importance	Description
ABP	9.545701E-01	Mancato allarme blocco pompa
P1	3.329860E-01	Guasto pompa 020.P.01 A
P2	3.329860E-01	Guasto pompa 020.P.01 B
P3	3.329860E-01	Guasto pompa 020.P.01 C
MIO	4.439861E-02	Mancato intervento operatore
S-SDV	1.031272E-03	Chiusura Spuria SDV
MIO1	1.031272E-03	Mancato intervento operatore
C-SDV	1.031272E-03	Mancato allarme chiusura SDV

Summary Table of Minimal Cut Sets Sorted vs. Order

Order	Number of MCSs	Cumulative Unavailability	% of TOP Unavailability	Cumulative ENF	% of TOP ENF
3	7	5.309931E-08	100.00	5.478866E-05	100.00

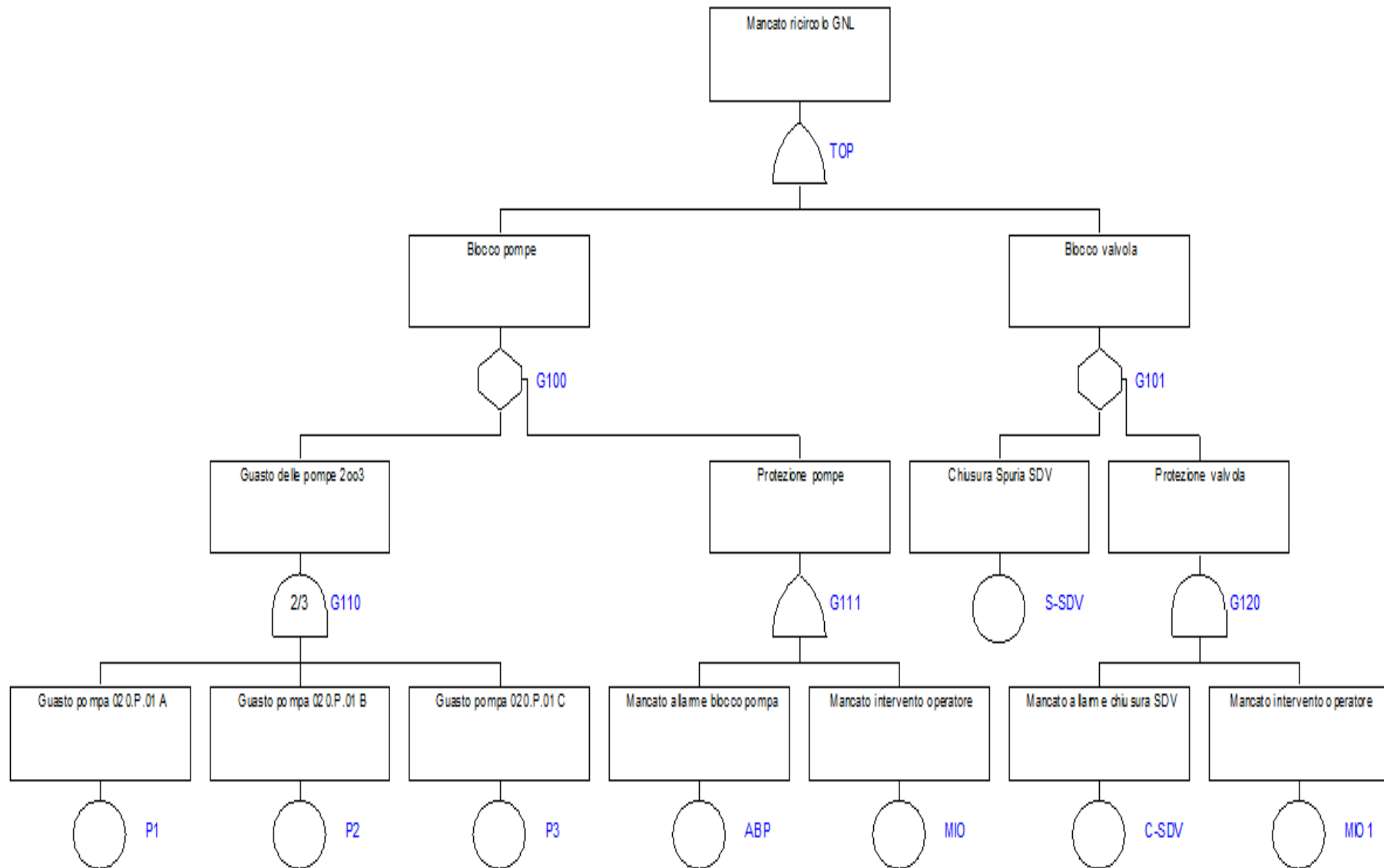
List of Minimal Cut Sets Sorted vs. Order

#	Minimal Cut Set		
1	C-SDV	MIO1	S-SDV
2	ABP	P1	P2
3	ABP	P1	P3
4	ABP	P2	P3
5	MIO	P1	P2
6	MIO	P1	P3
7	MIO	P2	P3

List of Minimal Cut Sets Sorted vs. ENF

#	Unavailability	ENF	Events		
1	1.690079E-08	1.743321E-05	ABP	P2	P3
2	1.690079E-08	1.743321E-05	ABP	P1	P2
3	1.690079E-08	1.743321E-05	ABP	P1	P3
4	7.860831E-10	8.108469E-07	MIO	P2	P3
5	7.860831E-10	8.108469E-07	MIO	P1	P2
6	7.860831E-10	8.108469E-07	MIO	P1	P3
7	3.869993E-11	5.650201E-08	C-SDV	MIO1	S-SDV

Evento: Mancato ricircolo GNL (roll over)



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FTA Report

Summary Data

General data

Project folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Project name:	NOF
Project version:	N/A
Tree name:	Roll over 2
Tree description:	Mancato controllo densità durante carico
Number of basic events:	24
Number of gates:	11
Number of good boundary conditions:	0
Number of failed boundary conditions:	0
Logical cut-off:	10
Probabilistic cut-off:	2.374291E-12
Mission time (hours):	8.760000E+03
Truncation error estimate:	Yes
Type of probabilistic analysis:	ENF - Expected number of failures
Report folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Report file name:	Roll over 2.rtf

Probabilistic Analysis results

Number of minimal cut-sets:	204
Maximum order of minimal cut-sets:	5
Unavailability of TOP event:	3.888149E-07
Expected number of Failures of TOP event:	1.173140E-03
Truncation error:	2.793284E-10
Analysis date (DD/MM/YYYY):	23/03/2016
Analysis time (HH:MM:SS):	15:05:49

Tree Structure

Gate name	Op.	Sons					Description
TOP	INH	G100	G101				Mancato controllo densità durante carico
G100	OR	G110	G111				Malfunzionamento sensori
G101	OR	MA	MIO				Protezione sensori
G110	OR	G120	DCS1				Sensori 1T
G111	OR	DCS2	G121				Sensori 2T
G120	AND	G130	G131				Guasto sensori S4oo10(1)
G121	AND	G132	-12				Guasto sensori S4oo10(2)
G130	2/5	S1	S2	S3	S4	S5	Guasto sensori S2oo5(1)
G131	2/5	S6	S7	S8	S9	S10	Guasto sensori S2oo5(2)
G132	2/5	S11	S12	S13	S14	S15	Guasto sensori S2oo5(3)
G133	2/5	S16	S17	S18	S19	S20	Guasto sensori S2oo5(4)

Primary Events Input Data

Event Name	Failure rate	Repair Time	On-demand unavailability	Test interval	Description
DCS1	2.480000E-05	2.900000E+00			Guasto Distributed Control System 1
DCS2	2.480000E-05	2.900000E+00			Guasto Distributed Control System 2
MA			1.700000E-03		Mancato funzionamento allarme
MIO			1.000000E-03		Mancato intervento operatore
S1	7.000000E-07				Guasto S1
S10	7.000000E-07				Guasto S10
S11	7.000000E-07				Guasto S11
S12	7.000000E-07				Guasto S12
S13	7.000000E-07				Guasto S13
S14	7.000000E-07				Guasto S14
S15	7.000000E-07				Guasto S15
S16	7.000000E-07				Guasto S16
S17	7.000000E-07				Guasto S17
S18	7.000000E-07				Guasto S18
S19	7.000000E-07				Guasto S19
S2	7.000000E-07				Guasto S2
S20	7.000000E-07				Guasto S20
S3	7.000000E-07				Guasto S3
S4	7.000000E-07				Guasto S4
S5	7.000000E-07				Guasto S5
S6	7.000000E-07				Guasto S6
S7	7.000000E-07				Guasto S7

Event Name	Failure rate	Repair Time	On-demand unavailability	Test interval	Description
S8	7.000000E-07				Guasto S8
S9	7.000000E-07				Guasto S9

Cross Reference Map of Events

Event Name	Parent Gates	Description
DCS1	G110	Guasto Distributed Control System 1
DCS2	G111	Guasto Distributed Control System 2
MA	G101	Mancato funzionamento allarme
MIO	G101	Mancato intervento operatore
S1	G130	Guasto S1
S10	G131	Guasto S10
S11	G132	Guasto S11
S12	G132	Guasto S12
S13	G132	Guasto S13
S14	G132	Guasto S14
S15	G132	Guasto S15
S16	G133	Guasto S16
S17	G133	Guasto S17
S18	G133	Guasto S18
S19	G133	Guasto S19
S2	G130	Guasto S2
S20	G133	Guasto S20
S3	G130	Guasto S3
S4	G130	Guasto S4
S5	G130	Guasto S5
S6	G131	Guasto S6
S7	G131	Guasto S7
S8	G131	Guasto S8

Event Name	Parent Gates	Description
S9	G131	Guasto S9

Cross Reference Map of Gates

Gate Name	Parent Gates	Description
G100	TOP	Malfunzionamento sensori
G101	TOP	Protezione sensori
G110	G100	Sensori 1T
G111	G100	Sensori 2T
G120	G110	Guasto sensori S4oo10(1)
G121	G111	Guasto sensori S4oo10(2)
G130	G120	Guasto sensori S2oo5(1)
G131	G120	Guasto sensori S2oo5(2)
G132	G121	Guasto sensori S2oo5(3)
G133	G121	Guasto sensori S2oo5(4)
TOP		Mancato controllo densità durante carico

Events Unavailability

Event Name	Unavailability	Description
S14	6.113238E-03	Guasto S14
S15	6.113238E-03	Guasto S15
S16	6.113238E-03	Guasto S16
S17	6.113238E-03	Guasto S17
S1	6.113238E-03	Guasto S1
S10	6.113238E-03	Guasto S10
S11	6.113238E-03	Guasto S11
S12	6.113238E-03	Guasto S12
S13	6.113238E-03	Guasto S13
S4	6.113238E-03	Guasto S4
S5	6.113238E-03	Guasto S5
S6	6.113238E-03	Guasto S6
S7	6.113238E-03	Guasto S7
S18	6.113238E-03	Guasto S18
S19	6.113238E-03	Guasto S19
S2	6.113238E-03	Guasto S2
S20	6.113238E-03	Guasto S20
S3	6.113238E-03	Guasto S3
S8	6.113238E-03	Guasto S8
S9	6.113238E-03	Guasto S9
MA	1.700000E-03	Mancato funzionamento allarme
MIO	1.000000E-03	Mancato intervento operatore

Event Name	Unavailability	Description
DCS1	7.191483E-05	Guasto Distributed Control System 1
DCS2	7.191483E-05	Guasto Distributed Control System 2

Events Importance

Event Name	Importance	Description
MA	6.296298E-01	Mancato funzionamento allarme
DCS1	4.996850E-01	Guasto Distributed Control System 1
DCS2	4.996850E-01	Guasto Distributed Control System 2
MIO	3.703702E-01	Mancato intervento operatore
S14	2.030090E-08	Guasto S14
S15	2.030090E-08	Guasto S15
S11	2.030090E-08	Guasto S11
S12	2.030090E-08	Guasto S12
S13	2.030090E-08	Guasto S13
S4	2.030090E-08	Guasto S4
S5	2.030090E-08	Guasto S5
S16	2.030090E-08	Guasto S16
S17	2.030090E-08	Guasto S17
S1	2.030090E-08	Guasto S1
S10	2.030090E-08	Guasto S10
S2	2.030090E-08	Guasto S2
S20	2.030090E-08	Guasto S20
S3	2.030090E-08	Guasto S3
S8	2.030090E-08	Guasto S8
S9	2.030090E-08	Guasto S9
S6	2.030090E-08	Guasto S6
S7	2.030090E-08	Guasto S7

Event Name	Importance	Description
S18	2.030090E-08	Guasto S18
S19	2.030090E-08	Guasto S19

Summary Table of Minimal Cut Sets Sorted vs. Order

Order	Number of MCSs	Cumulative Unavailability	% of TOP Unavailability	Cumulative ENF	% of TOP ENF
2	4	3.883401E-07	99.88	1.173139E-03	100.00
5	200	4.748583E-10	0.12	4.763157E-10	< 0.01

List of Minimal Cut Sets Sorted vs. Order

#	Minimal Cut Set					
1	DCS2	MA				
2	DCS1	MA				
3	DCS2	MIO				
4	DCS1	MIO				
5	MA	S4	S5	S6	S7	
6	MA	S10	S4	S5	S9	
7	MA	S4	S5	S7	S8	
8	MA	S4	S5	S7	S9	
9	MA	S4	S5	S8	S9	
10	MA	S1	S10	S4	S6	
11	MA	S1	S10	S4	S7	
12	MA	S1	S10	S4	S8	
13	MA	S1	S10	S4	S9	
14	MA	S4	S5	S6	S8	
15	MA	S4	S5	S6	S9	
16	MA	S1	S4	S6	S9	
17	MA	S1	S4	S7	S8	
18	MA	S1	S4	S7	S9	
19	MA	S1	S4	S8	S9	
20	MA	S10	S2	S4	S6	
21	MA	S10	S2	S4	S7	
22	MA	S10	S2	S4	S8	
23	MA	S10	S2	S4	S9	

#	Minimal Cut Set				
24	MA	S2	S4	S6	S7
25	MA	S2	S4	S6	S9
26	MA	S2	S4	S7	S8
27	MA	S2	S4	S7	S9
28	MA	S2	S4	S8	S9
29	MA	S10	S3	S4	S6
30	MA	S10	S3	S4	S7
31	MA	S10	S3	S4	S8
32	MA	S10	S3	S4	S9
33	MA	S3	S4	S6	S7
34	MA	S3	S4	S6	S8
35	MA	S3	S4	S6	S9
36	MA	S3	S4	S7	S8
37	MA	S3	S4	S7	S9
38	MA	S3	S4	S8	S9
39	MA	S1	S10	S5	S6
40	MA	S1	S10	S5	S7
41	MA	S1	S4	S6	S7
42	MA	S1	S4	S6	S8
43	MA	S1	S5	S6	S7
44	MA	S1	S5	S6	S8
45	MA	S1	S5	S6	S9
46	MA	S1	S5	S7	S8
47	MA	S1	S5	S7	S9
48	MA	S1	S5	S8	S9

#	Minimal Cut Set				
49	MA	S10	S2	S5	S6
50	MA	S10	S2	S5	S7
51	MA	S10	S2	S5	S8
52	MA	S10	S2	S5	S9
53	MA	S2	S5	S6	S7
54	MA	S2	S5	S6	S8
55	MA	S2	S5	S6	S9
56	MA	S2	S5	S7	S8
57	MA	S2	S5	S7	S9
58	MA	S2	S5	S8	S9
59	MA	S10	S3	S5	S6
60	MA	S10	S3	S5	S7
61	MA	S10	S3	S5	S8
62	MA	S10	S3	S5	S9
63	MA	S3	S5	S6	S7
64	MA	S3	S5	S6	S8
65	MA	S3	S5	S6	S9
66	MA	S3	S5	S7	S8
67	MA	S3	S5	S7	S9
68	MA	S3	S5	S8	S9
69	MA	S1	S10	S2	S6
70	MA	S1	S10	S2	S7
71	MA	S1	S10	S2	S8
72	MA	S1	S10	S2	S9
73	MA	S1	S2	S6	S7

#	Minimal Cut Set				
74	MA	S1	S2	S6	S8
75	MA	S1	S2	S6	S9
76	MA	S1	S2	S7	S8
77	MA	S1	S2	S7	S9
78	MA	S1	S2	S8	S9
79	MA	S1	S10	S3	S6
80	MA	S1	S10	S3	S7
81	MA	S1	S10	S3	S8
82	MA	S1	S10	S3	S9
83	MA	S1	S3	S6	S7
84	MA	S1	S3	S6	S8
85	MA	S1	S3	S6	S9
86	MA	S1	S3	S7	S8
87	MA	S1	S3	S7	S9
88	MA	S1	S3	S8	S9
89	MA	S10	S2	S3	S6
90	MA	S10	S2	S3	S7
91	MA	S10	S2	S3	S8
92	MA	S10	S2	S3	S9
93	MA	S2	S3	S6	S7
94	MA	S2	S3	S6	S8
95	MA	S2	S3	S6	S9
96	MA	S2	S3	S7	S8
97	MA	S2	S3	S7	S9
98	MA	S2	S3	S8	S9

#	Minimal Cut Set				
99	MA	S11	S12	S16	S20
100	MA	S11	S12	S17	S20
101	MA	S11	S12	S18	S20
102	MA	S11	S12	S19	S20
103	MA	S11	S12	S16	S17
104	MA	S11	S12	S16	S18
105	MA	S11	S12	S16	S19
106	MA	S11	S12	S17	S18
107	MA	S11	S12	S17	S19
108	MA	S11	S12	S18	S19
109	MA	S12	S15	S16	S20
110	MA	S12	S15	S17	S20
111	MA	S12	S15	S18	S20
112	MA	S12	S15	S19	S20
113	MA	S12	S15	S16	S17
114	MA	S12	S15	S16	S18
115	MA	S12	S15	S16	S19
116	MA	S12	S15	S17	S18
117	MA	S12	S15	S17	S19
118	MA	S12	S15	S18	S19
119	MA	S12	S13	S16	S20
120	MA	S12	S13	S17	S20
121	MA	S12	S13	S18	S20
122	MA	S1	S10	S5	S8
123	MA	S1	S10	S5	S9

#	Minimal Cut Set				
124	MA	S12	S13	S16	S18
125	MA	S12	S13	S16	S19
126	MA	S12	S13	S17	S18
127	MA	S12	S13	S17	S19
128	MA	S12	S13	S18	S19
129	MA	S12	S14	S16	S20
130	MA	S12	S14	S17	S20
131	MA	S12	S14	S18	S20
132	MA	S12	S14	S19	S20
133	MA	S12	S14	S16	S17
134	MA	S12	S14	S16	S18
135	MA	S12	S14	S16	S19
136	MA	S12	S14	S17	S18
137	MA	S12	S14	S17	S19
138	MA	S12	S14	S18	S19
139	MA	S11	S15	S16	S20
140	MA	S11	S15	S17	S20
141	MA	S11	S15	S18	S20
142	MA	S11	S15	S19	S20
143	MA	S11	S15	S16	S17
144	MA	S11	S15	S16	S18
145	MA	S11	S15	S16	S19
146	MA	S11	S15	S17	S18
147	MA	S11	S15	S17	S19
148	MA	S11	S15	S18	S19

#	Minimal Cut Set				
149	MA	S11	S13	S16	S20
150	MA	S11	S13	S17	S20
151	MA	S11	S13	S18	S20
152	MA	S11	S13	S19	S20
153	MA	S11	S13	S16	S17
154	MA	S11	S13	S16	S18
155	MA	S11	S13	S16	S19
156	MA	S11	S13	S17	S18
157	MA	S11	S13	S17	S19
158	MA	S11	S13	S18	S19
159	MA	S11	S14	S16	S20
160	MA	S11	S14	S17	S20
161	MA	S11	S14	S18	S20
162	MA	S11	S14	S19	S20
163	MA	S11	S14	S16	S17
164	MA	S11	S14	S16	S18
165	MA	S11	S14	S16	S19
166	MA	S11	S14	S17	S18
167	MA	S11	S14	S17	S19
168	MA	S11	S14	S18	S19
169	MA	S13	S15	S16	S20
170	MA	S13	S15	S17	S20
171	MA	S13	S15	S18	S20
172	MA	S13	S15	S19	S20
173	MA	S13	S15	S16	S17

#	Minimal Cut Set				
174	MA	S13	S15	S16	S18
175	MA	S13	S15	S16	S19
176	MA	S13	S15	S17	S18
177	MA	S13	S15	S17	S19
178	MA	S13	S15	S18	S19
179	MA	S14	S15	S16	S20
180	MA	S14	S15	S17	S20
181	MA	S14	S15	S18	S20
182	MA	S14	S15	S19	S20
183	MA	S14	S15	S16	S17
184	MA	S14	S15	S16	S18
185	MA	S14	S15	S16	S19
186	MA	S14	S15	S17	S18
187	MA	S14	S15	S17	S19
188	MA	S14	S15	S18	S19
189	MA	S13	S14	S16	S20
190	MA	S13	S14	S17	S20
191	MA	S13	S14	S18	S20
192	MA	S13	S14	S19	S20
193	MA	S13	S14	S16	S17
194	MA	S13	S14	S16	S18
195	MA	S13	S14	S16	S19
196	MA	S13	S14	S17	S18
197	MA	S13	S14	S17	S19
198	MA	S13	S14	S18	S19

#	Minimal Cut Set				
199	MA	S2	S4	S6	S8
200	MA	S10	S4	S5	S8
201	MA	S10	S4	S5	S6
202	MA	S10	S4	S5	S7
203	MA	S12	S13	S19	S20
204	MA	S12	S13	S16	S17

List of Minimal Cut Sets Sorted vs. ENF

#	Unavailability	ENF	Events				
1	1.222552E-07	3.693216E-04	DCS2	MA			
2	1.222552E-07	3.693216E-04	DCS1	MA			
3	7.191483E-08	2.172480E-04	DCS2	MIO			
4	7.191483E-08	2.172480E-04	DCS1	MIO			
5	2.374291E-12	2.381578E-12	MA	S4	S5	S6	S7
6	2.374291E-12	2.381578E-12	MA	S10	S4	S5	S9
7	2.374291E-12	2.381578E-12	MA	S4	S5	S7	S8
8	2.374291E-12	2.381578E-12	MA	S4	S5	S7	S9
9	2.374291E-12	2.381578E-12	MA	S4	S5	S8	S9
10	2.374291E-12	2.381578E-12	MA	S1	S10	S4	S6
11	2.374291E-12	2.381578E-12	MA	S1	S10	S4	S7
12	2.374291E-12	2.381578E-12	MA	S1	S10	S4	S8
13	2.374291E-12	2.381578E-12	MA	S1	S10	S4	S9
14	2.374291E-12	2.381578E-12	MA	S4	S5	S6	S8
15	2.374291E-12	2.381578E-12	MA	S4	S5	S6	S9
16	2.374291E-12	2.381578E-12	MA	S1	S4	S6	S9
17	2.374291E-12	2.381578E-12	MA	S1	S4	S7	S8
18	2.374291E-12	2.381578E-12	MA	S1	S4	S7	S9
19	2.374291E-12	2.381578E-12	MA	S1	S4	S8	S9
20	2.374291E-12	2.381578E-12	MA	S10	S2	S4	S6
21	2.374291E-12	2.381578E-12	MA	S10	S2	S4	S7
22	2.374291E-12	2.381578E-12	MA	S10	S2	S4	S8
23	2.374291E-12	2.381578E-12	MA	S10	S2	S4	S9

#	Unavailability	ENF	Events				
24	2.374291E-12	2.381578E-12	MA	S2	S4	S6	S7
25	2.374291E-12	2.381578E-12	MA	S2	S4	S6	S9
26	2.374291E-12	2.381578E-12	MA	S2	S4	S7	S8
27	2.374291E-12	2.381578E-12	MA	S2	S4	S7	S9
28	2.374291E-12	2.381578E-12	MA	S2	S4	S8	S9
29	2.374291E-12	2.381578E-12	MA	S10	S3	S4	S6
30	2.374291E-12	2.381578E-12	MA	S10	S3	S4	S7
31	2.374291E-12	2.381578E-12	MA	S10	S3	S4	S8
32	2.374291E-12	2.381578E-12	MA	S10	S3	S4	S9
33	2.374291E-12	2.381578E-12	MA	S3	S4	S6	S7
34	2.374291E-12	2.381578E-12	MA	S3	S4	S6	S8
35	2.374291E-12	2.381578E-12	MA	S3	S4	S6	S9
36	2.374291E-12	2.381578E-12	MA	S3	S4	S7	S8
37	2.374291E-12	2.381578E-12	MA	S3	S4	S7	S9
38	2.374291E-12	2.381578E-12	MA	S3	S4	S8	S9
39	2.374291E-12	2.381578E-12	MA	S1	S10	S5	S6
40	2.374291E-12	2.381578E-12	MA	S1	S10	S5	S7
41	2.374291E-12	2.381578E-12	MA	S1	S4	S6	S7
42	2.374291E-12	2.381578E-12	MA	S1	S4	S6	S8
43	2.374291E-12	2.381578E-12	MA	S1	S5	S6	S7
44	2.374291E-12	2.381578E-12	MA	S1	S5	S6	S8
45	2.374291E-12	2.381578E-12	MA	S1	S5	S6	S9
46	2.374291E-12	2.381578E-12	MA	S1	S5	S7	S8
47	2.374291E-12	2.381578E-12	MA	S1	S5	S7	S9
48	2.374291E-12	2.381578E-12	MA	S1	S5	S8	S9

#	Unavailability	ENF	Events				
49	2.374291E-12	2.381578E-12	MA	S10	S2	S5	S6
50	2.374291E-12	2.381578E-12	MA	S10	S2	S5	S7
51	2.374291E-12	2.381578E-12	MA	S10	S2	S5	S8
52	2.374291E-12	2.381578E-12	MA	S10	S2	S5	S9
53	2.374291E-12	2.381578E-12	MA	S2	S5	S6	S7
54	2.374291E-12	2.381578E-12	MA	S2	S5	S6	S8
55	2.374291E-12	2.381578E-12	MA	S2	S5	S6	S9
56	2.374291E-12	2.381578E-12	MA	S2	S5	S7	S8
57	2.374291E-12	2.381578E-12	MA	S2	S5	S7	S9
58	2.374291E-12	2.381578E-12	MA	S2	S5	S8	S9
59	2.374291E-12	2.381578E-12	MA	S10	S3	S5	S6
60	2.374291E-12	2.381578E-12	MA	S10	S3	S5	S7
61	2.374291E-12	2.381578E-12	MA	S10	S3	S5	S8
62	2.374291E-12	2.381578E-12	MA	S10	S3	S5	S9
63	2.374291E-12	2.381578E-12	MA	S3	S5	S6	S7
64	2.374291E-12	2.381578E-12	MA	S3	S5	S6	S8
65	2.374291E-12	2.381578E-12	MA	S3	S5	S6	S9
66	2.374291E-12	2.381578E-12	MA	S3	S5	S7	S8
67	2.374291E-12	2.381578E-12	MA	S3	S5	S7	S9
68	2.374291E-12	2.381578E-12	MA	S3	S5	S8	S9
69	2.374291E-12	2.381578E-12	MA	S1	S10	S2	S6
70	2.374291E-12	2.381578E-12	MA	S1	S10	S2	S7
71	2.374291E-12	2.381578E-12	MA	S1	S10	S2	S8
72	2.374291E-12	2.381578E-12	MA	S1	S10	S2	S9
73	2.374291E-12	2.381578E-12	MA	S1	S2	S6	S7

#	Unavailability	ENF	Events				
74	2.374291E-12	2.381578E-12	MA	S1	S2	S6	S8
75	2.374291E-12	2.381578E-12	MA	S1	S2	S6	S9
76	2.374291E-12	2.381578E-12	MA	S1	S2	S7	S8
77	2.374291E-12	2.381578E-12	MA	S1	S2	S7	S9
78	2.374291E-12	2.381578E-12	MA	S1	S2	S8	S9
79	2.374291E-12	2.381578E-12	MA	S1	S10	S3	S6
80	2.374291E-12	2.381578E-12	MA	S1	S10	S3	S7
81	2.374291E-12	2.381578E-12	MA	S1	S10	S3	S8
82	2.374291E-12	2.381578E-12	MA	S1	S10	S3	S9
83	2.374291E-12	2.381578E-12	MA	S1	S3	S6	S7
84	2.374291E-12	2.381578E-12	MA	S1	S3	S6	S8
85	2.374291E-12	2.381578E-12	MA	S1	S3	S6	S9
86	2.374291E-12	2.381578E-12	MA	S1	S3	S7	S8
87	2.374291E-12	2.381578E-12	MA	S1	S3	S7	S9
88	2.374291E-12	2.381578E-12	MA	S1	S3	S8	S9
89	2.374291E-12	2.381578E-12	MA	S10	S2	S3	S6
90	2.374291E-12	2.381578E-12	MA	S10	S2	S3	S7
91	2.374291E-12	2.381578E-12	MA	S10	S2	S3	S8
92	2.374291E-12	2.381578E-12	MA	S10	S2	S3	S9
93	2.374291E-12	2.381578E-12	MA	S2	S3	S6	S7
94	2.374291E-12	2.381578E-12	MA	S2	S3	S6	S8
95	2.374291E-12	2.381578E-12	MA	S2	S3	S6	S9
96	2.374291E-12	2.381578E-12	MA	S2	S3	S7	S8
97	2.374291E-12	2.381578E-12	MA	S2	S3	S7	S9
98	2.374291E-12	2.381578E-12	MA	S2	S3	S8	S9

#	Unavailability	ENF	Events				
99	2.374291E-12	2.381578E-12	MA	S11	S12	S16	S20
100	2.374291E-12	2.381578E-12	MA	S11	S12	S17	S20
101	2.374291E-12	2.381578E-12	MA	S11	S12	S18	S20
102	2.374291E-12	2.381578E-12	MA	S11	S12	S19	S20
103	2.374291E-12	2.381578E-12	MA	S11	S12	S16	S17
104	2.374291E-12	2.381578E-12	MA	S11	S12	S16	S18
105	2.374291E-12	2.381578E-12	MA	S11	S12	S16	S19
106	2.374291E-12	2.381578E-12	MA	S11	S12	S17	S18
107	2.374291E-12	2.381578E-12	MA	S11	S12	S17	S19
108	2.374291E-12	2.381578E-12	MA	S11	S12	S18	S19
109	2.374291E-12	2.381578E-12	MA	S12	S15	S16	S20
110	2.374291E-12	2.381578E-12	MA	S12	S15	S17	S20
111	2.374291E-12	2.381578E-12	MA	S12	S15	S18	S20
112	2.374291E-12	2.381578E-12	MA	S12	S15	S19	S20
113	2.374291E-12	2.381578E-12	MA	S12	S15	S16	S17
114	2.374291E-12	2.381578E-12	MA	S12	S15	S16	S18
115	2.374291E-12	2.381578E-12	MA	S12	S15	S16	S19
116	2.374291E-12	2.381578E-12	MA	S12	S15	S17	S18
117	2.374291E-12	2.381578E-12	MA	S12	S15	S17	S19
118	2.374291E-12	2.381578E-12	MA	S12	S15	S18	S19
119	2.374291E-12	2.381578E-12	MA	S12	S13	S16	S20
120	2.374291E-12	2.381578E-12	MA	S12	S13	S17	S20
121	2.374291E-12	2.381578E-12	MA	S12	S13	S18	S20
122	2.374291E-12	2.381578E-12	MA	S1	S10	S5	S8
123	2.374291E-12	2.381578E-12	MA	S1	S10	S5	S9

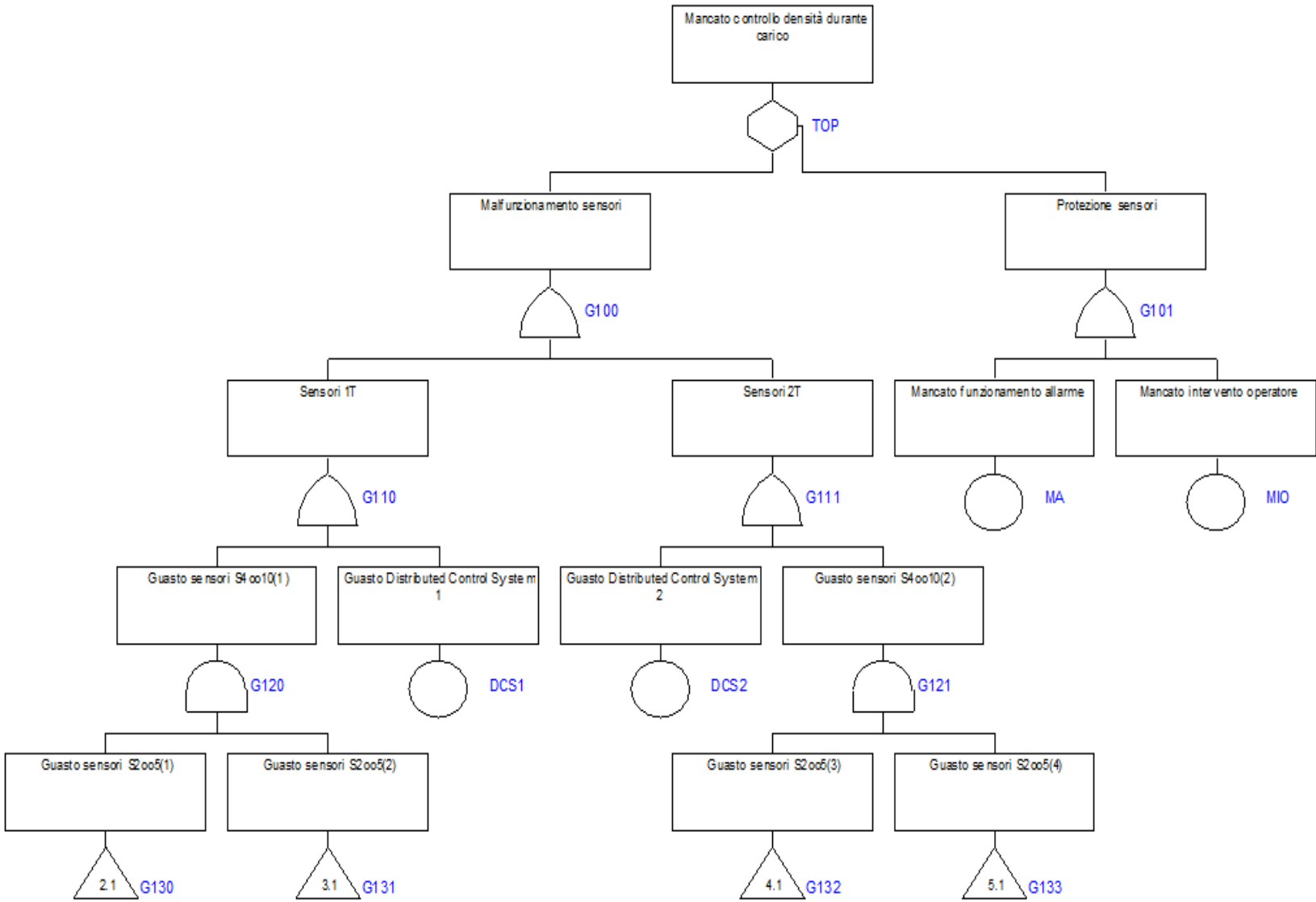
#	Unavailability	ENF	Events				
124	2.374291E-12	2.381578E-12	MA	S12	S13	S16	S18
125	2.374291E-12	2.381578E-12	MA	S12	S13	S16	S19
126	2.374291E-12	2.381578E-12	MA	S12	S13	S17	S18
127	2.374291E-12	2.381578E-12	MA	S12	S13	S17	S19
128	2.374291E-12	2.381578E-12	MA	S12	S13	S18	S19
129	2.374291E-12	2.381578E-12	MA	S12	S14	S16	S20
130	2.374291E-12	2.381578E-12	MA	S12	S14	S17	S20
131	2.374291E-12	2.381578E-12	MA	S12	S14	S18	S20
132	2.374291E-12	2.381578E-12	MA	S12	S14	S19	S20
133	2.374291E-12	2.381578E-12	MA	S12	S14	S16	S17
134	2.374291E-12	2.381578E-12	MA	S12	S14	S16	S18
135	2.374291E-12	2.381578E-12	MA	S12	S14	S16	S19
136	2.374291E-12	2.381578E-12	MA	S12	S14	S17	S18
137	2.374291E-12	2.381578E-12	MA	S12	S14	S17	S19
138	2.374291E-12	2.381578E-12	MA	S12	S14	S18	S19
139	2.374291E-12	2.381578E-12	MA	S11	S15	S16	S20
140	2.374291E-12	2.381578E-12	MA	S11	S15	S17	S20
141	2.374291E-12	2.381578E-12	MA	S11	S15	S18	S20
142	2.374291E-12	2.381578E-12	MA	S11	S15	S19	S20
143	2.374291E-12	2.381578E-12	MA	S11	S15	S16	S17
144	2.374291E-12	2.381578E-12	MA	S11	S15	S16	S18
145	2.374291E-12	2.381578E-12	MA	S11	S15	S16	S19
146	2.374291E-12	2.381578E-12	MA	S11	S15	S17	S18
147	2.374291E-12	2.381578E-12	MA	S11	S15	S17	S19
148	2.374291E-12	2.381578E-12	MA	S11	S15	S18	S19

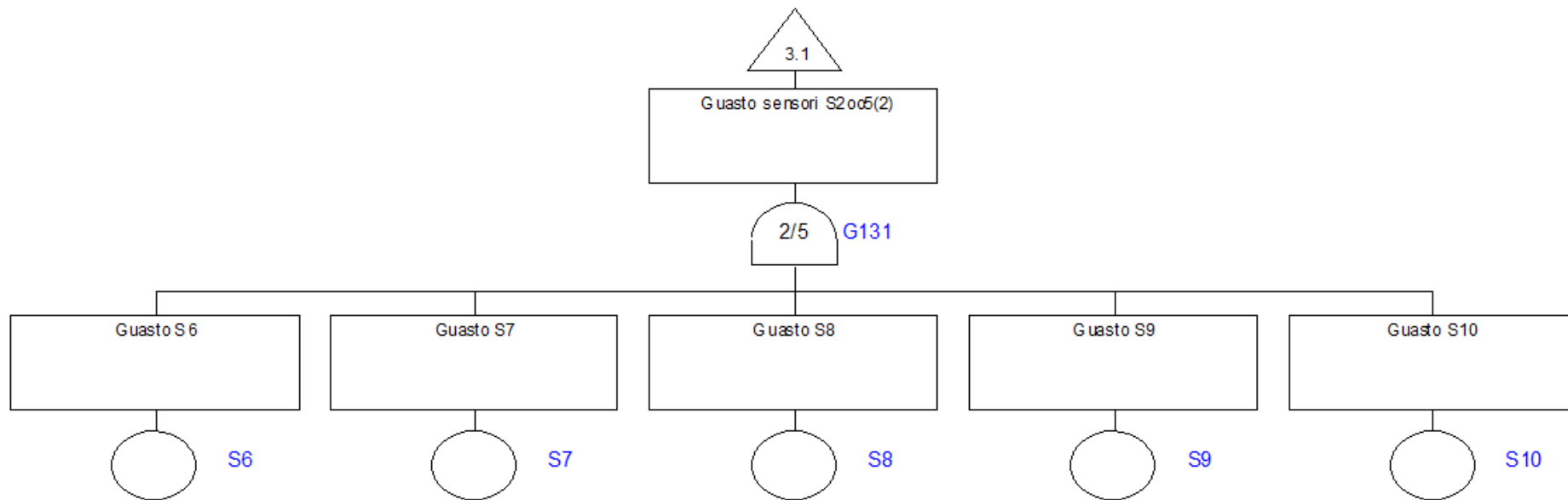
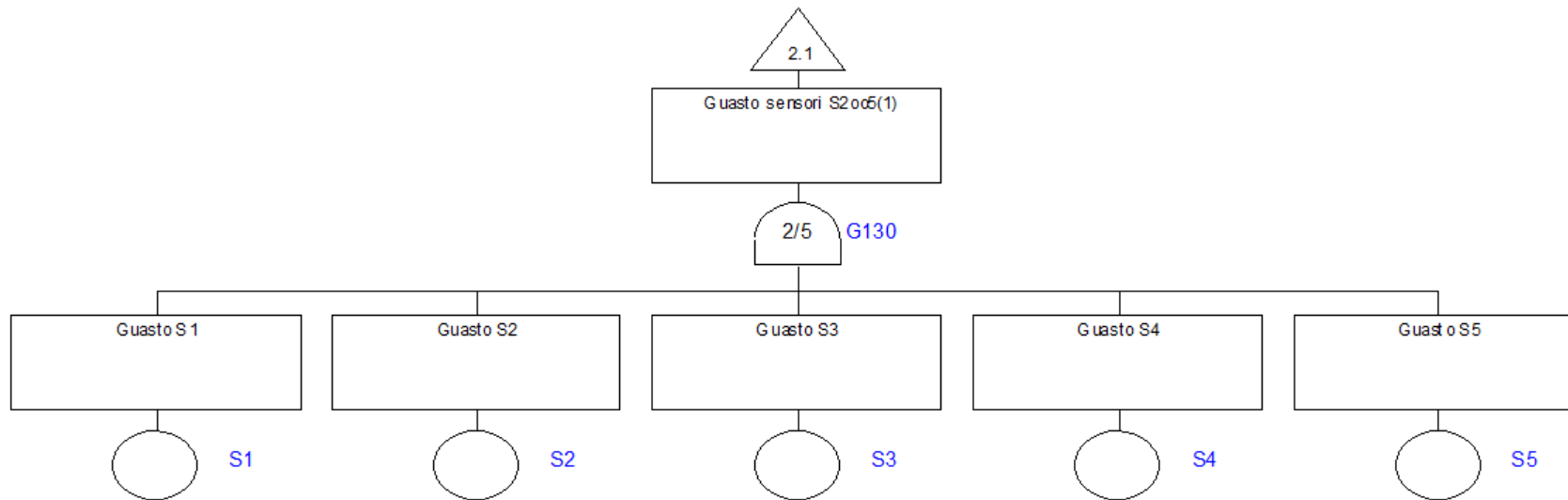
#	Unavailability	ENF	Events				
149	2.374291E-12	2.381578E-12	MA	S11	S13	S16	S20
150	2.374291E-12	2.381578E-12	MA	S11	S13	S17	S20
151	2.374291E-12	2.381578E-12	MA	S11	S13	S18	S20
152	2.374291E-12	2.381578E-12	MA	S11	S13	S19	S20
153	2.374291E-12	2.381578E-12	MA	S11	S13	S16	S17
154	2.374291E-12	2.381578E-12	MA	S11	S13	S16	S18
155	2.374291E-12	2.381578E-12	MA	S11	S13	S16	S19
156	2.374291E-12	2.381578E-12	MA	S11	S13	S17	S18
157	2.374291E-12	2.381578E-12	MA	S11	S13	S17	S19
158	2.374291E-12	2.381578E-12	MA	S11	S13	S18	S19
159	2.374291E-12	2.381578E-12	MA	S11	S14	S16	S20
160	2.374291E-12	2.381578E-12	MA	S11	S14	S17	S20
161	2.374291E-12	2.381578E-12	MA	S11	S14	S18	S20
162	2.374291E-12	2.381578E-12	MA	S11	S14	S19	S20
163	2.374291E-12	2.381578E-12	MA	S11	S14	S16	S17
164	2.374291E-12	2.381578E-12	MA	S11	S14	S16	S18
165	2.374291E-12	2.381578E-12	MA	S11	S14	S16	S19
166	2.374291E-12	2.381578E-12	MA	S11	S14	S17	S18
167	2.374291E-12	2.381578E-12	MA	S11	S14	S17	S19
168	2.374291E-12	2.381578E-12	MA	S11	S14	S18	S19
169	2.374291E-12	2.381578E-12	MA	S13	S15	S16	S20
170	2.374291E-12	2.381578E-12	MA	S13	S15	S17	S20
171	2.374291E-12	2.381578E-12	MA	S13	S15	S18	S20
172	2.374291E-12	2.381578E-12	MA	S13	S15	S19	S20
173	2.374291E-12	2.381578E-12	MA	S13	S15	S16	S17

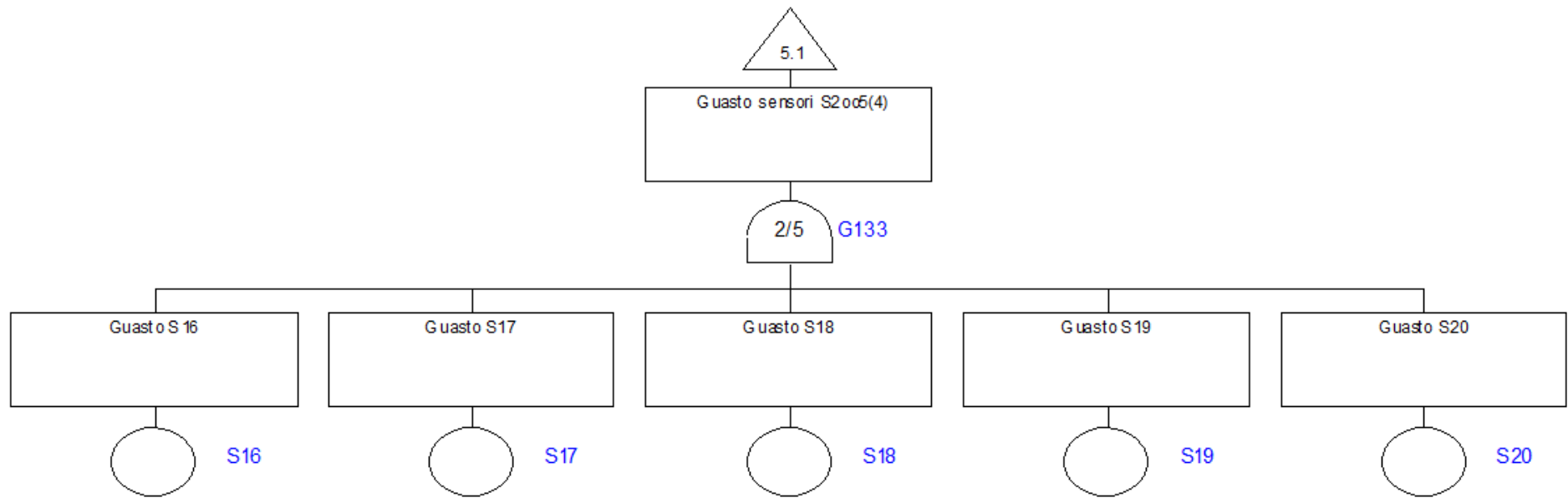
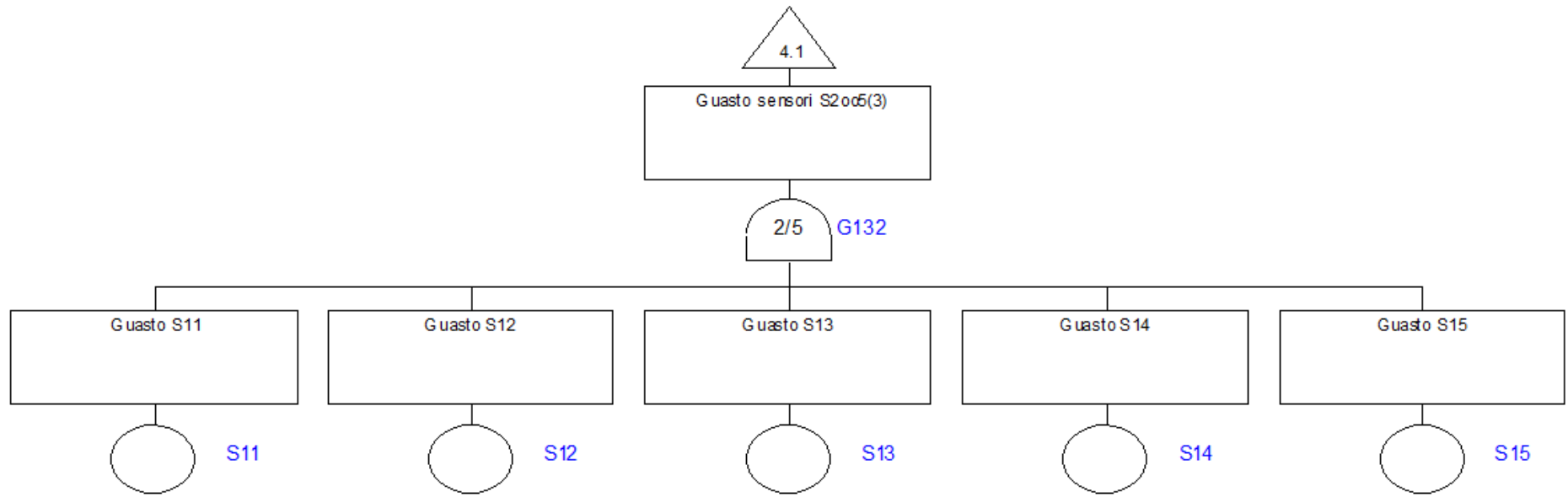
#	Unavailability	ENF	Events				
174	2.374291E-12	2.381578E-12	MA	S13	S15	S16	S18
175	2.374291E-12	2.381578E-12	MA	S13	S15	S16	S19
176	2.374291E-12	2.381578E-12	MA	S13	S15	S17	S18
177	2.374291E-12	2.381578E-12	MA	S13	S15	S17	S19
178	2.374291E-12	2.381578E-12	MA	S13	S15	S18	S19
179	2.374291E-12	2.381578E-12	MA	S14	S15	S16	S20
180	2.374291E-12	2.381578E-12	MA	S14	S15	S17	S20
181	2.374291E-12	2.381578E-12	MA	S14	S15	S18	S20
182	2.374291E-12	2.381578E-12	MA	S14	S15	S19	S20
183	2.374291E-12	2.381578E-12	MA	S14	S15	S16	S17
184	2.374291E-12	2.381578E-12	MA	S14	S15	S16	S18
185	2.374291E-12	2.381578E-12	MA	S14	S15	S16	S19
186	2.374291E-12	2.381578E-12	MA	S14	S15	S17	S18
187	2.374291E-12	2.381578E-12	MA	S14	S15	S17	S19
188	2.374291E-12	2.381578E-12	MA	S14	S15	S18	S19
189	2.374291E-12	2.381578E-12	MA	S13	S14	S16	S20
190	2.374291E-12	2.381578E-12	MA	S13	S14	S17	S20
191	2.374291E-12	2.381578E-12	MA	S13	S14	S18	S20
192	2.374291E-12	2.381578E-12	MA	S13	S14	S19	S20
193	2.374291E-12	2.381578E-12	MA	S13	S14	S16	S17
194	2.374291E-12	2.381578E-12	MA	S13	S14	S16	S18
195	2.374291E-12	2.381578E-12	MA	S13	S14	S16	S19
196	2.374291E-12	2.381578E-12	MA	S13	S14	S17	S18
197	2.374291E-12	2.381578E-12	MA	S13	S14	S17	S19
198	2.374291E-12	2.381578E-12	MA	S13	S14	S18	S19

#	Unavailability	ENF	Events				
199	2.374291E-12	2.381578E-12	MA	S2	S4	S6	S8
200	2.374291E-12	2.381578E-12	MA	S10	S4	S5	S8
201	2.374291E-12	2.381578E-12	MA	S10	S4	S5	S6
202	2.374291E-12	2.381578E-12	MA	S10	S4	S5	S7
203	2.374291E-12	2.381578E-12	MA	S12	S13	S19	S20
204	2.374291E-12	2.381578E-12	MA	S12	S13	S16	S17

Evento: Mancato controllo densità durante carico







ASTRA - PMX

**Advanced Software Tool for Reliability
Analysis**

FTA Report

Summary Data

General data

Project folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Project name:	NOF
Project version:	N/A
Tree name:	Sovrapressione Serbatoio
Tree description:	Sovrapressione Serbatoio GNL
Number of basic events:	33
Number of gates:	15
Number of good boundary conditions:	0
Number of failed boundary conditions:	0
Logical cut-off:	10
Probabilistic cut-off:	1.000000E-12
Mission time (hours):	8.760000E+03
Truncation error estimate:	Yes
Type of probabilistic analysis:	ENF - Expected number of failures
Report folder:	L:\Proj\2015\15-018-HSE2\eng\work\NOF\Alberi di Guasto\ASTRA\NOF\NOF\
Report file name:	Sovrapressione Serbatoio.rtf

Probabilistic Analysis results

Number of minimal cut-sets:	4
Maximum order of minimal cut-sets:	4
Unavailability of TOP event:	1.032547E-06
Expected number of Failures of TOP event:	1.217943E-06
Truncation error:	0.000000E+00
Analysis date (DD/MM/YYYY):	05/04/2016
Analysis time (HH:MM:SS):	16:52:33

Tree Structure

Gate name	Op.	Sons				Description
TOP	AND	G300	G400			Sovrapressione Serb. GNL (att.PSV tetto)
G300	OR	G201	MCD			Effetto Roll Over
G400	3/4	PSV1	PSV2	PSV3	PSV4	Malfunzionamento PSV
G201	AND	G210	G211			Mancato ricircolo LNG
G210	INH	G220	G221			Blocco pompe
G211	INH	S-SDV	G230			Blocco valvola
G220	2/3	P1	P2	P3		Guasto delle pompe 2oo3
G221	AND	ABP	MIO1			Protezione pompe
G230	OR	C-SDV	MIO2			Protezione valvola

Primary Events Input Data

Event Name	Failure rate	Repair Time	On-demand unavailability	Test interval	Description
ABP			2.150000E-02		Mancato allarme blocco pompa
C-SDV			2.150000E-02		Mancato allarme chiusura SDV
MCD	3.880000E-05				Mancato controllo densità durante carico
MIO1			1.000000E-03		Mancato intervento operatore
MIO2			1.000000E-03		Mancato intervento operatore
P1	5.220000E-05	1.700000E+01			Guasto pompa 02.P.01 A
P2	5.220000E-05	1.700000E+01			Guasto pompa 02.P.01 B
P3	5.220000E-05	1.700000E+01			Guasto pompa 02.P.01 C
PSV1			9.640000E-03		Guasto Pressure Safety Valve 1
PSV2			9.640000E-03		Guasto Pressure Safety Valve 2
PSV3			9.640000E-03		Guasto Pressure Safety Valve 3
PSV4			9.640000E-03		Guasto Pressure Safety Valve 4
S-SDV	3.000000E-07	5.999999E+00			Chiusura spuria SDV

Cross Reference Map of Events

Event Name	Parent Gates	Description
ABP	G221	Mancato allarme blocco pompa
C-SDV	G230	Mancato allarme chiusura SDV
MCD	G300	Mancato controllo densità durante carico
MIO1	G221	Mancato intervento operatore
MIO2	G230	Mancato intervento operatore
P1	G220	Guasto pompa 02.P.01 A
P2	G220	Guasto pompa 02.P.01 B
P3	G220	Guasto pompa 02.P.01 C
PSV1	G400	Guasto Pressure Safety Valve 1
PSV2	G400	Guasto Pressure Safety Valve 2
PSV3	G400	Guasto Pressure Safety Valve 3
PSV4	G400	Guasto Pressure Safety Valve 4
S-SDV	G211	Chiusura spuria SDV

Cross Reference Map of Gates

Gate Name	Parent Gates	Description
G201	G300	Mancato ricircolo LNG
G210	G201	Blocco pompe
G211	G201	Blocco valvola
G220	G210	Guasto delle pompe 2oo3
G221	G210	Protezione pompe
G230	G211	Protezione valvola
G300	TOP	Effetto Roll Over
G400	TOP	Malfunzionamento PSV
TOP		Sovrapressione Serb. GNL (att.PSV tetto)

Events Unavailability

Event Name	Unavailability	Description
MCD	2.881500E-01	Mancato controllo densità durante carico
ABP	2.150000E-02	Mancato allarme blocco pompa
C-SDV	2.150000E-02	Mancato allarme chiusura SDV
PSV2	9.640000E-03	Guasto Pressure Safety Valve 2
PSV3	9.640000E-03	Guasto Pressure Safety Valve 3
PSV1	9.640000E-03	Guasto Pressure Safety Valve 1
PSV4	9.640000E-03	Guasto Pressure Safety Valve 4
MIO1	1.000000E-03	Mancato intervento operatore
MIO2	1.000000E-03	Mancato intervento operatore
P2	8.866132E-04	Guasto pompa 02.P.01 B
P3	8.866132E-04	Guasto pompa 02.P.01 C
P1	8.866132E-04	Guasto pompa 02.P.01 A
S-SDV	1.799996E-06	Chiusura spuria SDV

Events Importance

Event Name	Importance	Description
MCD	9.999987E-01	Mancato controllo densità durante carico
PSV3	7.500000E-01	Guasto Pressure Safety Valve 3
PSV1	7.500000E-01	Guasto Pressure Safety Valve 1
PSV2	7.500000E-01	Guasto Pressure Safety Valve 2
PSV4	7.500000E-01	Guasto Pressure Safety Valve 4
ABP		Mancato allarme blocco pompa
C-SDV		Mancato allarme chiusura SDV
MIO1		Mancato intervento operatore
MIO2		Mancato intervento operatore
P2		Guasto pompa 02.P.01 B
P3		Guasto pompa 02.P.01 C
P1		Guasto pompa 02.P.01 A
S-SDV		Chiusura spuria SDV

Summary Table of Minimal Cut Sets Sorted vs. Order

Order	Number of MCSs	Cumulative Unavailability	% of TOP Unavailability	Cumulative ENF	% of TOP ENF
4	4	1.032547E-06	100.00	1.217943E-06	100.00

List of Minimal Cut Sets Sorted vs. Order

#	Minimal Cut Set			
1	MCD	PSV1	PSV2	PSV3
2	MCD	PSV1	PSV2	PSV4
3	MCD	PSV1	PSV3	PSV4
4	MCD	PSV2	PSV3	PSV4

List of Minimal Cut Sets Sorted vs. ENF

#	Unavailability	ENF	Events			
1	2.581366E-07	3.044857E-07	MCD	PSV1	PSV2	PSV3
2	2.581366E-07	3.044857E-07	MCD	PSV1	PSV2	PSV4
3	2.581366E-07	3.044857E-07	MCD	PSV1	PSV3	PSV4
4	2.581366E-07	3.044857E-07	MCD	PSV2	PSV3	PSV4

Evento: Sovrapressione Serbatoio GNL con attivazione PSV tetto

