Appendices

A. Improved fail-safe SPO results

Table 8. *Optimal improved-fail-safe sensor distributions obtained by a GA combined with the DFIM weighted by the ADPR.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
4	5,12,28[b],36	2.707e-08	2.384e-07
5	24,28,31,34,36	6.195e-07	3.170e-06
6	4,24,28,34,35,36[a]	1.781e-06	6.260e-06
7	4,12,24,28,34,35,36	5.047e-06	1.266e-05
8	12,16,24,28,31,34,35,36	8.679e-06	1.924e-05

[a] The failure of a sensor at the position marked in blue will result in the worst fitness.

[b] From a fail-safe perspective, the replaceable sensor location is marked in magenta.

Table 9. *Optimal improved-fail-safe sensor distributions obtained by an GA combined with the SSC.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
2	3,34	0.363	0.781
3	8,27,34	0.756	1.393
4	3,8,30,34	1.164	1.504
5	3,8,27,30,34	1.504	1.719
6	1,15,18,25,30,34	1.890	2.225
7	1,3,17,18,25,30,34	2.083	2.327
8	1,4,17,18,25,26,30,34	2.359	2.513

Table 10. *Optimal improved-fail-safe sensor distributions obtained by an GA combined with the SSC weighted by the ADPR.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
2	24,36	0.144	1.098
3	12,24,36	0.776	2.542
4	3,12,24,36	1.918	4.262
5	3,12,16,24,36	2.980	5.571
6	3,12,24,28,32,36	4.100	6.917
7	3,12,21,24,28,32,36	4.995	7.634
8	11,12,23,24,28,29,33,36	5.903	9.018

635 ## B. Improved fail-safe with redundancy SPO results

Table 11. *Optimal improved-fail-safe sensor distributions with redundancy obtained by a GA combined with the DFIM weighted by the ADPR.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
5	28,31,34,36 (36)^c	1.812e-07	9.313e-07
6	24,28 (28),34,35,36^d	9.469e-07	3.382e-06
7	12,16,24,28,34 (34),36	2.575e-06	6.4660e-06
8	4,12,16,24,34 (34),35,36	5.277e-06	1.181e-05

^{c} Sensors in parentheses are redundant sensors placed to avoid the worst fitness.

^{d} The failure of a sensor at the position marked in green will result in the second worst fitness.

Table 12. *Optimal improved-fail-safe sensor distributions with redundancy obtained by a GA combined with the SSC.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
3	8,34 (34)	0.379	0.943
4	8 (8),21,34	0.834	0.963
5	3,8,27,34 (34)	1.209	1.675
6	3,8,27 (27),30,34	1.567	1.719
7	3,15 (15),17,18,26,32	1.911	2.235
8	3,5,15 (15),17,18,26,32	2.217	2.391

Table 13. *Optimal improved-fail-safe sensor distributions with redundancy obtained by a GA combined with the SSC weighted by the ADPR.*

No. of sensors	Sensor number	Fail-safe fitness	Fitness
3	12,24 (24)	0.268	1.296
4	12,24 (24),36	1.098	2.542
5	12,16,24 (24),36	2.240	3.798
6	1,3,12 (12),24,36	3.125	5.098
7	3,12,24 (24),28,32,36	4.272	6.917
8	3,12,24 (24),28,32,33,36	5.207	7.870