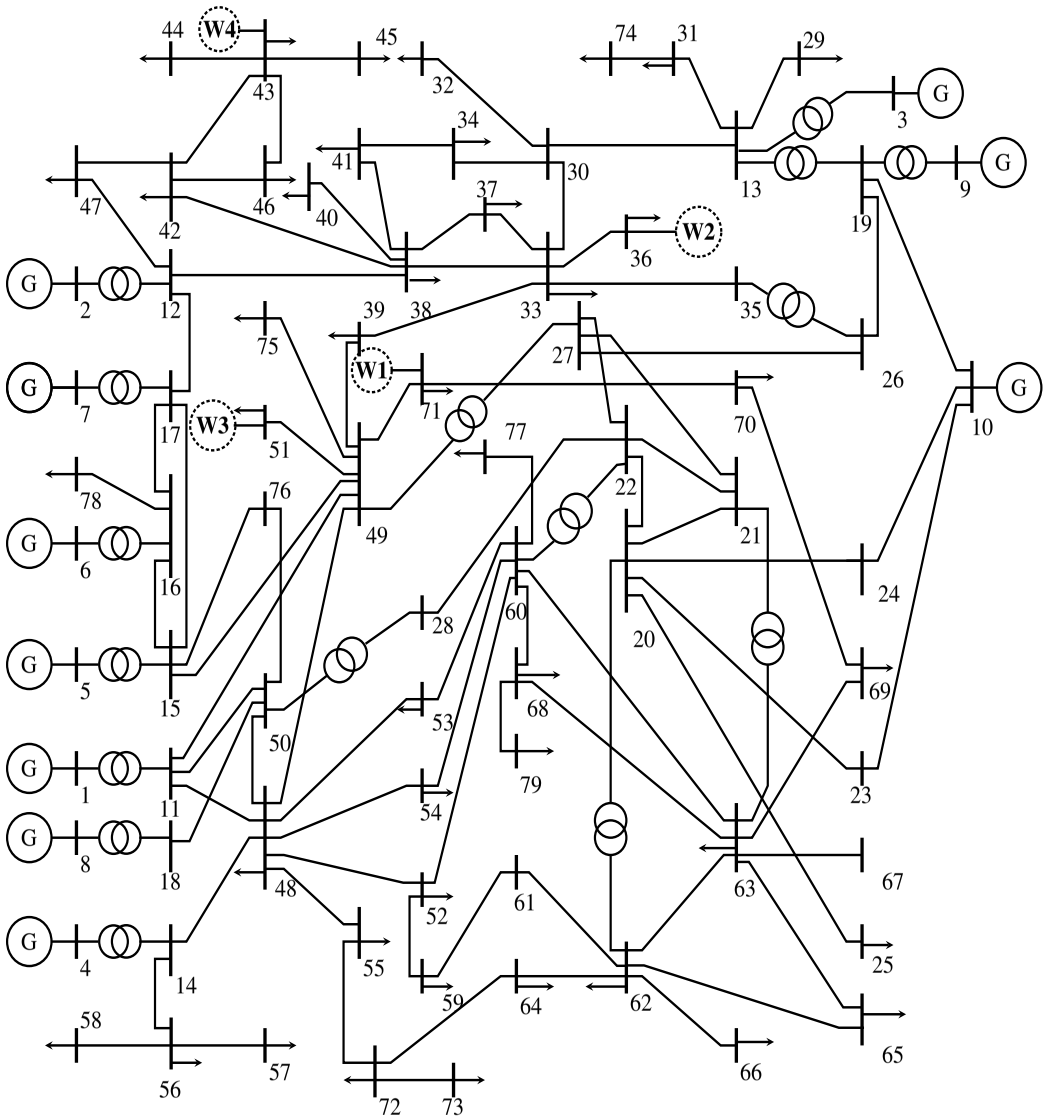
Appendix F

418 Bus Equivalent System of Indian Southern Grid

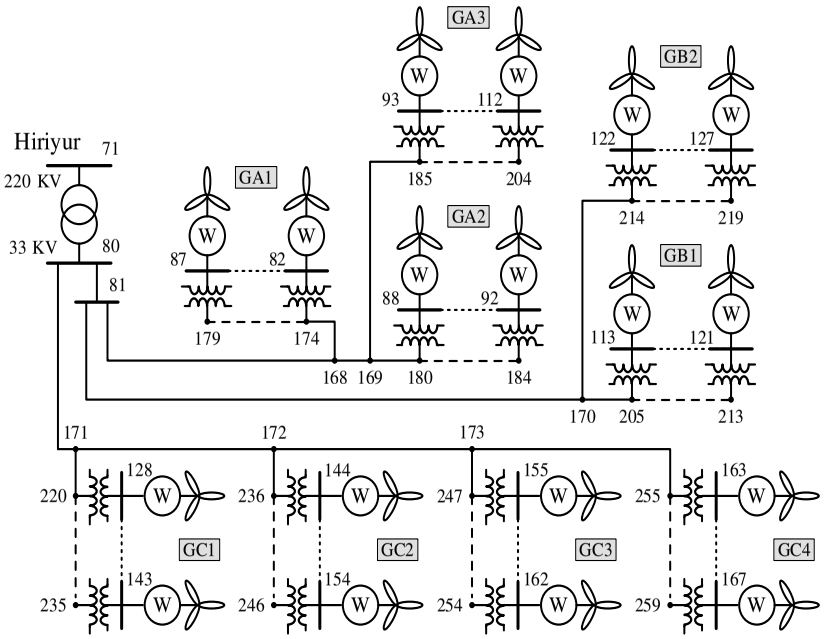
Table F.1: System information

Number of Synchronous Generators:	10
Number of variable speed wind generators:	164
Number of Transformers :	184
Number of Transmission Lines :	260
Number of Shunt Z-Loads :	9
Number of PQ - Loads :	56
Total P - Q Load:	4078.00 MW, 1210.00 MVAR

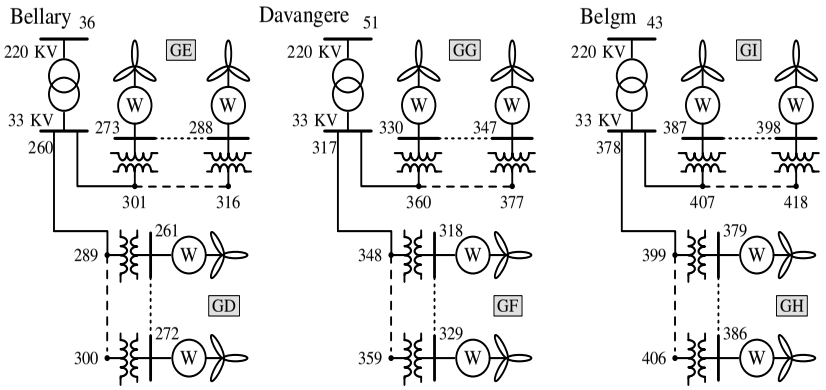
All the data is given in per unit (p.u) on 100 MVA base.



(a) Single line diagram of the system



(b) configuration of wind farm 1



(c) configuration of wind farms 2-4

Figure F.1: Single line diagram of the system and configuration of individual wind farms

Table F.2: **Transmission Line data**

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
20	21	0.0007	0.00824	0.10768	500.00
20	22	0.0008	0.01030	0.13460	500.00
20	23	0.0043	0.04770	0.63700	500.00
20	24	0.0059	0.05995	0.78410	500.00
20	25	0.0029	0.03603	0.46222	500.00
26	27	0.0020	0.02471	0.32304	500.00
26	19	0.0028	0.02998	0.42699	500.00
27	21	0.0055	0.06794	0.88836	500.00
27	22	0.0043	0.05352	0.69992	500.00
21	22	0.0012	0.01442	0.18844	500.00
28	22	0.0058	0.07206	0.94220	500.00
19	10	0.0048	0.05103	0.72673	500.00
13	29	0.0033	0.01652	0.01388	150.00
13	30	0.0053	0.02643	0.19986	450.00
13	31	0.0084	0.04213	0.14158	300.00
30	32	0.0206	0.10242	0.08605	150.00
30	33	0.0108	0.05369	0.17784	300.00
30	34	0.0115	0.05782	0.19432	300.00
33	35	0.0008	0.00372	0.01231	300.00
33	36	0.0113	0.05616	0.04688	150.00
33	37	0.0144	0.07186	0.05951	150.00
33	38	0.0227	0.11316	0.09371	150.00
33	39	0.0089	0.04460	0.03748	150.00
38	40	0.0088	0.04378	0.14572	300.00
38	41	0.0232	0.11564	0.09716	120.00
38	12	0.0027	0.01343	0.18040	480.00
38	37	0.0083	0.04130	0.03420	150.00
38	42	0.0013	0.00661	0.02189	300.00
41	34	0.0103	0.05162	0.17350	300.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
43	42	0.0100	0.04956	0.04104	150.00
43	44	0.0165	0.08260	0.06940	150.00
43	45	0.0248	0.12390	0.10410	150.00
43	46	0.0010	0.00486	0.00410	150.00
12	17	0.0033	0.01652	0.05552	300.00
12	47	0.0025	0.01239	0.04164	300.00
11	48	0.0045	0.02258	0.32200	600.00
11	49	0.0217	0.10821	0.09092	150.00
11	50	0.0013	0.00664	0.02359	300.00
51	49	0.0011	0.00550	0.04164	450.00
48	14	0.0075	0.03771	0.12312	300.00
48	52	0.0217	0.10779	0.35705	240.00
48	49	0.0062	0.03097	0.10410	300.00
48	53	0.0279	0.13876	0.11492	120.00
48	54	0.0307	0.15281	0.12654	120.00
48	55	0.0129	0.06402	0.21204	300.00
48	50	0.0082	0.04089	0.13543	300.00
14	56	0.0087	0.04337	0.14364	300.00
56	57	0.0033	0.01652	0.05472	300.00
56	58	0.0037	0.01817	0.06019	300.00
52	59	0.0031	0.01529	0.01283	150.00
52	60	0.0012	0.00620	0.02052	600.00
59	61	0.0016	0.00826	0.00694	150.00
62	63	0.0034	0.01728	0.01409	150.00
62	64	0.0063	0.03138	0.02637	150.00
62	64	0.0121	0.06020	0.04309	180.00
62	61	0.0050	0.02478	0.02082	150.00
62	65	0.0048	0.02390	0.02013	150.00
62	66	0.0083	0.04131	0.03469	150.00
63	67	0.0101	0.05040	0.04223	150.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
63	60	0.0116	0.05780	0.04858	150.00
63	65	0.0048	0.02390	0.02013	150.00
63	68	0.0058	0.02890	0.02429	150.00
63	69	0.0066	0.03304	0.02776	150.00
70	71	0.0224	0.11152	0.09234	120.00
70	69	0.0066	0.03304	0.02776	150.00
72	64	0.0125	0.06100	0.04446	150.00
72	55	0.0079	0.03924	0.12996	300.00
72	73	0.0020	0.00991	0.00833	150.00
71	49	0.0091	0.04543	0.15048	300.00
31	74	0.0070	0.03511	0.11798	300.00
49	15	0.0054	0.06604	0.32084	1000.00
49	39	0.0156	0.07764	0.06524	150.00
49	75	0.0041	0.02065	0.06940	300.00
53	60	0.0129	0.06443	0.05335	120.00
54	60	0.0101	0.05038	0.04174	120.00
60	68	0.0058	0.02890	0.02429	150.00
50	18	0.0032	0.01570	0.05274	300.00
50	76	0.0064	0.03180	0.10586	300.00
76	15	0.0031	0.03880	0.04642	500.00
60	77	0.0037	0.03620	0.03500	300.00
16	17	0.0069	0.03469	0.02915	150.00
16	15	0.0025	0.01239	0.01041	150.00
16	78	0.0012	0.00619	0.02082	300.00
17	15	0.0044	0.02230	0.01874	150.00
68	79	0.0002	0.00083	0.00070	150.00
42	46	0.0090	0.04460	0.03694	150.00
42	47	0.0054	0.02684	0.09022	300.00
10	24	0.0057	0.06008	0.79414	500.00
10	23	0.0027	0.02872	1.51829	1000.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
80	81	0.0415	0.06887	0.00040	50.00
81	170	0.0415	0.06887	0.00024	50.00
80	171	0.0415	0.06887	0.00024	50.00
81	168	0.0415	0.06887	0.00024	50.00
168	169	0.0415	0.06887	0.00024	50.00
169	185	0.0415	0.06887	0.00024	50.00
170	214	0.1244	0.20661	0.00008	50.00
171	172	0.0415	0.06887	0.00024	50.00
172	173	0.1244	0.20661	0.00008	50.00
173	255	0.1244	0.20661	0.00008	50.00
260	289	0.0415	0.06887	0.00040	50.00
260	301	0.0415	0.06887	0.00040	50.00
317	348	0.0415	0.06887	0.00040	50.00
317	360	0.0415	0.06887	0.00040	50.00
378	399	0.0415	0.06887	0.00040	50.00
378	407	0.0415	0.06887	0.00040	50.00
168	174	0.0037	0.00298	0.00022	50.00
174	175	0.0037	0.00298	0.00022	50.00
175	176	0.0037	0.00298	0.00022	50.00
176	177	0.0037	0.00298	0.00022	50.00
177	178	0.0037	0.00298	0.00022	50.00
178	179	0.0037	0.00298	0.00022	50.00
169	180	0.0037	0.00298	0.00022	50.00
180	181	0.0037	0.00298	0.00022	50.00
181	182	0.0037	0.00298	0.00022	50.00
182	183	0.0037	0.00298	0.00022	50.00
183	184	0.0037	0.00298	0.00022	50.00
185	186	0.0037	0.00298	0.00022	50.00
186	187	0.0037	0.00298	0.00022	50.00
187	188	0.0037	0.00298	0.00022	50.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
188	189	0.0037	0.00298	0.00022	50.00
189	190	0.0037	0.00298	0.00022	50.00
190	191	0.0037	0.00298	0.00022	50.00
191	192	0.0037	0.00298	0.00022	50.00
192	193	0.0037	0.00298	0.00022	50.00
193	194	0.0037	0.00298	0.00022	50.00
194	195	0.0037	0.00298	0.00022	50.00
195	196	0.0037	0.00298	0.00022	50.00
196	197	0.0037	0.00298	0.00022	50.00
197	198	0.0037	0.00298	0.00022	50.00
198	199	0.0037	0.00298	0.00022	50.00
199	200	0.0037	0.00298	0.00022	50.00
200	201	0.0037	0.00298	0.00022	50.00
201	202	0.0037	0.00298	0.00022	50.00
202	203	0.0037	0.00298	0.00022	50.00
203	204	0.0037	0.00298	0.00022	50.00
170	205	0.0037	0.00298	0.00022	50.00
205	206	0.0037	0.00298	0.00022	50.00
206	207	0.0037	0.00298	0.00022	50.00
207	208	0.0037	0.00298	0.00022	50.00
208	209	0.0037	0.00298	0.00022	50.00
209	210	0.0037	0.00298	0.00022	50.00
210	211	0.0037	0.00298	0.00022	50.00
211	212	0.0037	0.00298	0.00022	50.00
212	213	0.0037	0.00298	0.00022	50.00
214	215	0.0037	0.00298	0.00022	50.00
215	216	0.0037	0.00298	0.00022	50.00
216	217	0.0037	0.00298	0.00022	50.00
217	218	0.0037	0.00298	0.00022	50.00
218	219	0.0037	0.00298	0.00022	50.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
171	220	0.0037	0.00298	0.00022	50.00
220	221	0.0037	0.00298	0.00022	50.00
221	222	0.0037	0.00298	0.00022	50.00
222	223	0.0037	0.00298	0.00022	50.00
223	224	0.0037	0.00298	0.00022	50.00
224	225	0.0037	0.00298	0.00022	50.00
225	226	0.0037	0.00298	0.00022	50.00
226	227	0.0037	0.00298	0.00022	50.00
227	228	0.0037	0.00298	0.00022	50.00
228	229	0.0037	0.00298	0.00022	50.00
229	230	0.0037	0.00298	0.00022	50.00
230	231	0.0037	0.00298	0.00022	50.00
231	232	0.0037	0.00298	0.00022	50.00
232	233	0.0037	0.00298	0.00022	50.00
233	234	0.0037	0.00298	0.00022	50.00
234	235	0.0037	0.00298	0.00022	50.00
172	236	0.0037	0.00298	0.00022	50.00
236	237	0.0037	0.00298	0.00022	50.00
237	238	0.0037	0.00298	0.00022	50.00
238	239	0.0037	0.00298	0.00022	50.00
239	240	0.0037	0.00298	0.00022	50.00
240	241	0.0037	0.00298	0.00022	50.00
241	242	0.0037	0.00298	0.00022	50.00
242	243	0.0037	0.00298	0.00022	50.00
243	244	0.0037	0.00298	0.00022	50.00
244	245	0.0037	0.00298	0.00022	50.00
245	246	0.0037	0.00298	0.00022	50.00
173	247	0.0037	0.00298	0.00022	50.00
247	248	0.0037	0.00298	0.00022	50.00
248	249	0.0037	0.00298	0.00022	50.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
249	250	0.0037	0.00298	0.00022	50.00
250	251	0.0037	0.00298	0.00022	50.00
251	252	0.0037	0.00298	0.00022	50.00
252	253	0.0037	0.00298	0.00022	50.00
253	254	0.0037	0.00298	0.00022	50.00
255	256	0.0037	0.00298	0.00022	50.00
256	257	0.0037	0.00298	0.00022	50.00
257	258	0.0037	0.00298	0.00022	50.00
258	259	0.0037	0.00298	0.00022	50.00
289	290	0.0037	0.00298	0.00022	50.00
290	291	0.0037	0.00298	0.00022	50.00
291	292	0.0037	0.00298	0.00022	50.00
292	293	0.0037	0.00298	0.00022	50.00
293	294	0.0037	0.00298	0.00022	50.00
294	295	0.0037	0.00298	0.00022	50.00
295	296	0.0037	0.00298	0.00022	50.00
296	297	0.0037	0.00298	0.00022	50.00
297	298	0.0037	0.00298	0.00022	50.00
298	299	0.0037	0.00298	0.00022	50.00
299	300	0.0037	0.00298	0.00022	50.00
301	302	0.0037	0.00298	0.00022	50.00
302	303	0.0037	0.00298	0.00022	50.00
303	304	0.0037	0.00298	0.00022	50.00
304	305	0.0037	0.00298	0.00022	50.00
305	306	0.0037	0.00298	0.00022	50.00
306	307	0.0037	0.00298	0.00022	50.00
307	308	0.0037	0.00298	0.00022	50.00
308	309	0.0037	0.00298	0.00022	50.00
309	310	0.0037	0.00298	0.00022	50.00
310	311	0.0037	0.00298	0.00022	50.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
311	312	0.0037	0.00298	0.00022	50.00
312	313	0.0037	0.00298	0.00022	50.00
313	314	0.0037	0.00298	0.00022	50.00
314	315	0.0037	0.00298	0.00022	50.00
315	316	0.0037	0.00298	0.00022	50.00
348	349	0.0037	0.00298	0.00022	50.00
349	350	0.0037	0.00298	0.00022	50.00
350	351	0.0037	0.00298	0.00022	50.00
351	352	0.0037	0.00298	0.00022	50.00
352	353	0.0037	0.00298	0.00022	50.00
353	354	0.0037	0.00298	0.00022	50.00
354	355	0.0037	0.00298	0.00022	50.00
355	356	0.0037	0.00298	0.00022	50.00
356	357	0.0037	0.00298	0.00022	50.00
357	358	0.0037	0.00298	0.00022	50.00
358	359	0.0037	0.00298	0.00022	50.00
360	361	0.0037	0.00298	0.00022	50.00
361	362	0.0037	0.00298	0.00022	50.00
362	363	0.0037	0.00298	0.00022	50.00
363	364	0.0037	0.00298	0.00022	50.00
364	365	0.0037	0.00298	0.00022	50.00
365	366	0.0037	0.00298	0.00022	50.00
366	367	0.0037	0.00298	0.00022	50.00
367	368	0.0037	0.00298	0.00022	50.00
368	369	0.0037	0.00298	0.00022	50.00
369	370	0.0037	0.00298	0.00022	50.00
370	371	0.0037	0.00298	0.00022	50.00
371	372	0.0037	0.00298	0.00022	50.00
372	373	0.0037	0.00298	0.00022	50.00
373	374	0.0037	0.00298	0.00022	50.00

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Table F.2 – continued from previous page

From	To	R (p.u)	X (p.u)	$\frac{b}{2}$ (p.u)	Max Loading (MVA)
374	375	0.0037	0.00298	0.00022	50.00
375	376	0.0037	0.00298	0.00022	50.00
376	377	0.0037	0.00298	0.00022	50.00
399	400	0.0037	0.00298	0.00022	50.00
400	401	0.0037	0.00298	0.00022	50.00
401	402	0.0037	0.00298	0.00022	50.00
402	403	0.0037	0.00298	0.00022	50.00
403	404	0.0037	0.00298	0.00022	50.00
404	405	0.0037	0.00298	0.00022	50.00
405	406	0.0037	0.00298	0.00022	50.00
407	408	0.0037	0.00298	0.00022	50.00
408	409	0.0037	0.00298	0.00022	50.00
409	410	0.0037	0.00298	0.00022	50.00
410	411	0.0037	0.00298	0.00022	50.00
411	412	0.0037	0.00298	0.00022	50.00
412	413	0.0037	0.00298	0.00022	50.00
413	414	0.0037	0.00298	0.00022	50.00
414	415	0.0037	0.00298	0.00022	50.00
415	416	0.0037	0.00298	0.00022	50.00
416	417	0.0037	0.00298	0.00022	50.00
417	418	0.0037	0.00298	0.00022	50.00

Table F.3: **Transformers data**

From	To	R (p.u)	X (p.u)	Tap(a)	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
11	1	0.0003	0.00667	1.02500	900.00		
12	2	0.0006	0.01163	1.02500	700.00		
13	3	0.0007	0.01403	1.02500	500.00		
14	4	0.0013	0.02667	1.02500	300.00		

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
15	5	0.0011	0.02182	1.02500	500.00		
16	6	0.0033	0.06548	1.02500	500.00		
17	7	0.0043	0.08519	1.02500	500.00		
18	8	0.0024	0.04883	1.02500	500.00		
19	9	0.0029	0.05800	1.02500	500.00		
20	62	0.0006	0.01250	0.97500	500.00	1.01	1.01
26	35	0.0020	0.03960	0.97500	500.00	0.98	0.94
27	49	0.0020	0.03960	0.97500	500.00	1.01	1.04
28	50	0.0010	0.01980	0.97500	500.00	1.0	1.0
22	60	0.0013	0.02500	0.97500	500.00	1.05	1.06
19	13	0.0020	0.03960	0.97500	500.00	0.9	0.91
21	63	0.0013	0.02500	0.97500	500.00	1.05	1.05
71	80	0.0063	0.12500	1.00000	100.00	1.09	1.1
36	260	0.0063	0.12500	1.00000	100.00	1.03	1.03
51	317	0.0063	0.12500	1.00000	100.00	1.03	1.03
43	378	0.0063	0.12500	1.00000	100.00	0.94	0.94
174	82	0.1800	3.59999	1.00000	2.50	1.09	1.1
175	83	0.1800	3.59999	1.00000	2.50	1.09	1.1
176	84	0.1800	3.59999	1.00000	2.50	1.09	1.1
177	85	0.1800	3.59999	1.00000	2.50	1.09	1.1
178	86	0.1800	3.59999	1.00000	2.50	1.09	1.1
179	87	0.1800	3.59999	1.00000	2.50	1.09	1.1
180	88	0.1800	3.59999	1.00000	2.50	1.09	1.1
181	89	0.1800	3.59999	1.00000	2.50	1.09	1.1
182	90	0.1800	3.59999	1.00000	2.50	1.09	1.1
183	91	0.1800	3.59999	1.00000	2.50	1.09	1.1
184	92	0.1800	3.59999	1.00000	2.50	1.07	1.0
185	93	0.1800	3.59999	1.00000	2.50	1.09	1.1
186	94	0.1800	3.59999	1.00000	2.50	1.08	1.08
187	95	0.1800	3.59999	1.00000	2.50	1.05	1.05

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
188	96	0.1800	3.59999	1.00000	2.50	1.05	1.06
189	97	0.1800	3.59999	1.00000	2.50	1.05	1.06
190	98	0.1800	3.59999	1.00000	2.50	1.05	1.06
191	99	0.1800	3.59999	1.00000	2.50	1.05	1.06
192	100	0.1800	3.59999	1.00000	2.50	1.05	1.06
193	101	0.1800	3.59999	1.00000	2.50	1.05	1.06
194	102	0.1800	3.59999	1.00000	2.50	1.05	1.06
195	103	0.1800	3.59999	1.00000	2.50	1.05	1.06
196	104	0.1800	3.59999	1.00000	2.50	1.05	1.06
197	105	0.1800	3.59999	1.00000	2.50	1.05	1.06
198	106	0.1800	3.59999	1.00000	2.50	1.05	1.06
199	107	0.1800	3.59999	1.00000	2.50	1.05	1.06
200	108	0.1800	3.59999	1.00000	2.50	1.05	1.06
201	109	0.1800	3.59999	1.00000	2.50	1.05	1.06
202	110	0.1800	3.59999	1.00000	2.50	1.05	1.06
203	111	0.1800	3.59999	1.00000	2.50	1.05	1.06
204	112	0.1800	3.59999	1.00000	2.50	1.05	1.06
205	113	0.1800	3.59999	1.00000	2.50	1.09	1.10
206	114	0.1800	3.59999	1.00000	2.50	1.09	1.10
207	115	0.1800	3.59999	1.00000	2.50	1.09	1.10
208	116	0.1800	3.59999	1.00000	2.50	1.09	1.10
209	117	0.1800	3.59999	1.00000	2.50	1.09	1.10
210	118	0.1800	3.59999	1.00000	2.50	1.09	1.10
211	119	0.1800	3.59999	1.00000	2.50	1.09	1.10
212	120	0.1800	3.59999	1.00000	2.50	1.09	1.10
213	121	0.1800	3.59999	1.00000	2.50	1.09	1.10
214	122	0.1800	3.59999	1.00000	2.50	1.09	1.10
215	123	0.1800	3.59999	1.00000	2.50	1.09	1.10
216	124	0.1800	3.59999	1.00000	2.50	1.09	1.10
217	125	0.1800	3.59999	1.00000	2.50	1.09	1.10

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
218	126	0.1800	3.59999	1.00000	2.50	1.09	1.10
219	127	0.1800	3.59999	1.00000	2.50	1.09	1.09
220	128	0.1800	3.59999	1.00000	2.50	1.09	1.09
221	129	0.1800	3.59999	1.00000	2.50	1.09	1.10
222	130	0.1800	3.59999	1.00000	2.50	1.09	1.10
223	131	0.1800	3.59999	1.00000	2.50	1.09	1.10
224	132	0.1800	3.59999	1.00000	2.50	1.09	1.10
225	133	0.1800	3.59999	1.00000	2.50	1.09	1.10
226	134	0.1800	3.59999	1.00000	2.50	1.09	1.10
227	135	0.1800	3.59999	1.00000	2.50	1.09	1.10
228	136	0.1800	3.59999	1.00000	2.50	1.09	1.10
229	137	0.1800	3.59999	1.00000	2.50	1.09	1.10
230	138	0.1800	3.59999	1.00000	2.50	1.09	1.10
231	139	0.1800	3.59999	1.00000	2.50	1.09	1.10
232	140	0.1800	3.59999	1.00000	2.50	1.09	1.10
233	141	0.1800	3.59999	1.00000	2.50	1.09	1.10
234	142	0.1800	3.59999	1.00000	2.50	1.09	1.10
235	143	0.1800	3.59999	1.00000	2.50	1.09	1.10
236	144	0.1800	3.59999	1.00000	2.50	1.09	1.10
237	145	0.1800	3.59999	1.00000	2.50	1.09	1.10
238	146	0.1800	3.59999	1.00000	2.50	1.09	1.10
239	147	0.1800	3.59999	1.00000	2.50	1.09	1.10
240	148	0.1800	3.59999	1.00000	2.50	1.09	1.10
241	149	0.1800	3.59999	1.00000	2.50	1.09	1.10
242	150	0.1800	3.59999	1.00000	2.50	1.09	1.10
243	151	0.1800	3.59999	1.00000	2.50	1.09	1.10
244	152	0.1800	3.59999	1.00000	2.50	1.09	1.10
245	153	0.1800	3.59999	1.00000	2.50	1.09	1.10
246	154	0.1800	3.59999	1.00000	2.50	1.09	1.10
247	155	0.1800	3.59999	1.00000	2.50	1.09	1.10

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
248	156	0.1800	3.59999	1.00000	2.50	1.09	1.10
249	157	0.1800	3.59999	1.00000	2.50	1.09	1.10
250	158	0.1800	3.59999	1.00000	2.50	1.09	1.10
251	159	0.1800	3.59999	1.00000	2.50	1.09	1.10
252	160	0.1800	3.59999	1.00000	2.50	1.08	1.09
253	161	0.1800	3.59999	1.00000	2.50	1.06	1.06
254	162	0.1800	3.59999	1.00000	2.50	1.06	1.07
255	163	0.1800	3.59999	1.00000	2.50	1.09	1.10
256	164	0.1800	3.59999	1.00000	2.50	1.07	1.08
257	165	0.1800	3.59999	1.00000	2.50	1.06	1.07
258	166	0.1800	3.59999	1.00000	2.50	1.06	1.07
259	167	0.1800	3.59999	1.00000	2.50	1.06	1.07
289	261	0.2250	4.49999	1.00000	2.00	1.09	1.09
290	262	0.2250	4.49999	1.00000	2.00	1.09	1.09
291	263	0.2250	4.49999	1.00000	2.00	1.09	1.09
292	264	0.2250	4.49999	1.00000	2.00	1.09	1.09
293	265	0.2250	4.49999	1.00000	2.00	1.09	1.09
294	266	0.2250	4.49999	1.00000	2.00	1.09	1.09
295	267	0.2250	4.49999	1.00000	2.00	1.09	1.09
296	268	0.2250	4.49999	1.00000	2.00	1.09	1.09
297	269	0.2250	4.49999	1.00000	2.00	1.09	1.09
298	270	0.2250	4.49999	1.00000	2.00	1.09	1.09
299	271	0.2250	4.49999	1.00000	2.00	1.09	1.09
300	272	0.2250	4.49999	1.00000	2.00	1.09	1.09
301	273	0.2250	4.49999	1.00000	2.00	1.09	1.09
302	274	0.2250	4.49999	1.00000	2.00	1.09	1.09
303	275	0.2250	4.49999	1.00000	2.00	1.09	1.09
304	276	0.2250	4.49999	1.00000	2.00	1.09	1.09
305	277	0.2250	4.49999	1.00000	2.00	1.09	1.09
306	278	0.2250	4.49999	1.00000	2.00	1.09	1.09

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
307	279	0.2250	4.49999	1.00000	2.00	1.09	1.09
308	280	0.2250	4.49999	1.00000	2.00	1.09	1.09
309	281	0.2250	4.49999	1.00000	2.00	1.09	1.09
310	282	0.2250	4.49999	1.00000	2.00	1.09	1.09
311	283	0.2250	4.49999	1.00000	2.00	1.09	1.09
312	284	0.2250	4.49999	1.00000	2.00	1.09	1.09
313	285	0.2250	4.49999	1.00000	2.00	1.09	1.09
314	286	0.2250	4.49999	1.00000	2.00	1.09	1.09
315	287	0.2250	4.49999	1.00000	2.00	1.09	1.09
316	288	0.2250	4.49999	1.00000	2.00	1.09	1.09
348	318	0.1800	3.59999	1.00000	2.50	1.09	1.09
349	319	0.1800	3.59999	1.00000	2.50	1.09	1.09
350	320	0.1800	3.59999	1.00000	2.50	1.09	1.09
351	321	0.1800	3.59999	1.00000	2.50	1.09	1.09
352	322	0.1800	3.59999	1.00000	2.50	1.09	1.09
353	323	0.1800	3.59999	1.00000	2.50	1.09	1.09
354	324	0.1800	3.59999	1.00000	2.50	1.09	1.09
355	325	0.1800	3.59999	1.00000	2.50	1.09	1.09
356	326	0.1800	3.59999	1.00000	2.50	1.09	1.09
357	327	0.1800	3.59999	1.00000	2.50	1.09	1.09
358	328	0.1800	3.59999	1.00000	2.50	1.09	1.09
359	329	0.1800	3.59999	1.00000	2.50	1.09	1.09
360	330	0.1800	3.59999	1.00000	2.50	1.09	1.09
361	331	0.1800	3.59999	1.00000	2.50	1.09	1.09
362	332	0.1800	3.59999	1.00000	2.50	1.09	1.09
363	333	0.1800	3.59999	1.00000	2.50	1.09	1.09
364	334	0.1800	3.59999	1.00000	2.50	1.09	1.09
365	335	0.1800	3.59999	1.00000	2.50	1.09	1.09
366	336	0.1800	3.59999	1.00000	2.50	1.09	1.09
367	337	0.1800	3.59999	1.00000	2.50	1.09	1.09

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Table F.3 – continued from previous page

From	To	R (p.u)	X (p.u)	Tap	Max Loading (MVA)	a_{opt} (Case I)	a_{opt} (Case II)
368	338	0.1800	3.59999	1.00000	2.50	1.09	1.09
369	339	0.1800	3.59999	1.00000	2.50	1.09	1.09
370	340	0.1800	3.59999	1.00000	2.50	1.09	1.09
371	341	0.1800	3.59999	1.00000	2.50	1.09	1.09
372	342	0.1800	3.59999	1.00000	2.50	1.09	1.09
373	343	0.1800	3.59999	1.00000	2.50	1.09	1.09
374	344	0.1800	3.59999	1.00000	2.50	1.09	1.09
375	345	0.1800	3.59999	1.00000	2.50	1.09	1.09
376	346	0.1800	3.59999	1.00000	2.50	1.09	1.09
377	347	0.1800	3.59999	1.00000	2.50	1.09	1.09
399	379	0.1800	3.59999	1.00000	2.50	1.09	1.09
400	380	0.1800	3.59999	1.00000	2.50	1.09	1.09
401	381	0.1800	3.59999	1.00000	2.50	1.09	1.09
402	382	0.1800	3.59999	1.00000	2.50	1.09	1.09
403	383	0.1800	3.59999	1.00000	2.50	1.09	1.09
404	384	0.1800	3.59999	1.00000	2.50	1.09	1.09
405	385	0.1800	3.59999	1.00000	2.50	1.09	1.06
406	386	0.1800	3.59999	1.00000	2.50	1.09	1.06
407	387	0.1800	3.59999	1.00000	2.50	1.09	1.10
408	388	0.1800	3.59999	1.00000	2.50	1.09	1.10
409	389	0.1800	3.59999	1.00000	2.50	1.09	1.10
410	390	0.1800	3.59999	1.00000	2.50	1.09	1.10
411	391	0.1800	3.59999	1.00000	2.50	1.09	1.10
412	392	0.1800	3.59999	1.00000	2.50	1.09	1.10
413	393	0.1800	3.59999	1.00000	2.50	1.09	1.10
414	394	0.1800	3.59999	1.00000	2.50	1.08	1.08
415	395	0.1800	3.59999	1.00000	2.50	1.06	1.06
416	396	0.1800	3.59999	1.00000	2.50	1.06	1.06
417	397	0.1800	3.59999	1.00000	2.50	1.06	1.06
418	398	0.1800	3.59999	1.00000	2.50	1.06	1.06

Table F.4: **Load data of SVC buses**

Bus	P (MW)	Q (MVAr)	SVC Q_{max}	SVC Q_{min}	SVC Q_{step}
44	43.00	25.00	15.00	0.00	5.00
57	193.00	50.00	30.00	-5.00	5.00
59	122.00	50.00	30.00	0.00	5.00
70	44.00	1.17	30.00	0.00	5.00
72	208.00	32.00	30.00	0.00	5.00
73	55.00	9.00	15.00	0.00	5.00
77	58.00	20.00	15.00	0.00	5.00
81	0.00	0.00	10.00	-5.00	1.00
168	0.00	0.00	10.00	-5.00	1.00
169	0.00	0.00	10.00	0.00	1.00
170	0.00	0.00	10.00	0.00	1.00
171	0.00	0.00	10.00	0.00	1.00
172	0.00	0.00	10.00	0.00	1.00

Table F.5: **Load data of reaming load buses**

Bus	P (MW)	Q (MVAr)
56	52.00	-3.00
67	97.00	8.10
58	35.00	2.00
64	74.00	-11.39
69	47.00	12.34
77	26.00	14.00
32	74.00	21.00
41	110.00	43.00
52	183.00	-17.00

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Table F.5 – continued from previous page

Bus	P (MW)	Q (MVAr)
34	94.00	35.00
37	41.00	15.00
36	19.00	12.00
46	55.00	30.00
29	105.00	30.00
33	41.00	28.00
38	109.00	17.00
43	138.00	50.00
51	112.00	68.00
48	180.00	62.00
62	85.00	20.00
63	176.00	59.00
71	60.00	42.00
31	96.00	39.00
74	139.00	38.00
53	60.00	19.00
54	61.00	33.00
55	60.00	-14.00
61	103.00	35.00
65	76.00	8.00
66	76.00	31.00
15	100.00	37.00
68	99.00	42.00
42	30.00	2.00
78	26.00	18.00
39	46.00	23.00
75	46.00	40.00
47	24.00	6.00
79	3.50	1.70
23	117.00	110.00

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Table F.5 – continued from previous page

Bus	P (MW)	Q (MVAr)
24	10.00	53.00
25	65.00	-30.00
23	205.00	-5.00

Table F.6: **Shunt reactors data**

Bus	R (p.u)	X (p.u)
20	0.00	1.1025
26	0.00	1.7500
27	0.00	2.2050
28	0.00	1.1025
19	0.00	2.2050
22	0.00	2.7560
10	0.00	0.5176
23	0.00	1.1025
24	0.00	1.1025

Table F.7: **Conventional Generators Data**

Bus	P_{gen} Sch. (MW)	Q_{max} (MVAr)	Q_{min} (MVAr)
1 (slack)	879.99	450.00	-200.00
2	645.33	350.00	-100.00
3	488.88	320.00	-150.00
4	226.00	110.00	-80.00
5	390.00	200.00	-120.00
6	150.00	80.00	-40.00
7	120.00	60.00	-30.00
8	234.64	120.00	-60.00
9	175.98	90.00	-30.00

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Table F.7 – continued from previous page

Bus	P_{gen} Sch. (MW)	Q_{max} (MVAr)	Q_{min} (MVAr)
10	978.00	300.00	-50.00

Table F.8: **Optimal settings of wind generators (in MVAR)**

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
82	0.4541	0.667
83	0.4445	0.658
84	0.4491	0.65
85	0.4439	0.646
86	0.4398	0.65
87	0.4377	0.648
88	0.2481	0.456
89	0.2409	0.448
90	0.2355	0.443
91	0.2319	0.44
92	-0.1765	-0.362
93	0.2239	0.421
94	-0.1096	0.031
95	-0.6507	-0.447
96	-0.6652	-0.462
97	-0.6789	-0.477
98	-0.6916	-0.491
99	-0.7035	-0.503
100	-0.7146	-0.515
101	-0.7248	-0.526
102	-0.7341	-0.536
103	-0.7426	-0.545
104	-0.7503	-0.553

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Table F.8 – continued from previous page

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
105	-0.7571	-0.56
106	-0.7631	-0.566
107	-0.7682	-0.572
108	-0.7725	-0.577
109	-0.776	-0.58
110	-0.7787	-0.583
111	-0.7805	-0.585
112	-0.7815	-0.586
113	0.4897	0.694
114	0.4789	0.683
115	0.4695	0.674
116	0.4614	0.665
117	0.4547	0.658
118	0.4492	0.653
119	0.4452	0.648
120	0.4424	0.646
121	0.4409	0.644
122	0.2173	0.411
123	0.2088	0.403
124	0.2019	0.396
125	0.1968	0.39
126	0.1933	0.387
127	0.1915	0.332
128	0.693	1.081
129	0.693	1.07
130	0.693	1.047
131	0.693	1.025
132	0.693	1.005
133	0.693	0.987
134	0.693	0.971

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Table F.8 – continued from previous page

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
135	0.693	0.956
136	0.693	0.943
137	0.693	0.932
138	0.693	0.922
139	0.693	0.914
140	0.693	0.907
141	0.693	0.902
142	0.693	0.899
143	0.693	0.897
144	0.4962	0.699
145	0.4845	0.687
146	0.474	0.676
147	0.4646	0.667
148	0.4565	0.658
149	0.4495	0.651
150	0.4436	0.645
151	0.4389	0.64
152	0.4354	0.637
153	0.4329	0.634
154	0.4317	0.633
155	0.1979	0.384
156	0.1887	0.374
157	0.1809	0.366
158	0.1746	0.36
159	0.1698	0.355
160	0.0194	0.24
161	-0.5228	-0.332
162	-0.5157	-0.325
163	0.1318	0.31
164	-0.3147	-0.138

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Table F.8 – continued from previous page

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
165	-0.5636	-0.38
166	-0.5652	-0.381
167	-0.5581	-0.375
261	0.4269	0.404
262	0.418	0.398
263	0.4099	0.392
264	0.4026	0.387
265	0.3962	0.382
266	0.3905	0.378
267	0.3857	0.375
268	0.3816	0.372
269	0.3784	0.369
270	0.3759	0.368
271	0.3742	0.366
272	0.3733	0.366
273	0.4108	0.389
274	0.4021	0.381
275	0.3939	0.373
276	0.3864	0.366
277	0.3795	0.359
278	0.3731	0.353
279	0.3674	0.346
280	0.3622	0.341
281	0.3577	0.335
282	0.3536	0.33
283	0.3502	0.342
284	0.3473	0.339
285	0.345	0.335
286	0.3432	0.333
287	0.342	0.331

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Table F.8 – continued from previous page

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
288	0.3413	0.33
318	0.5431	0.677
319	0.5263	0.661
320	0.5111	0.646
321	0.4974	0.633
322	0.4853	0.622
323	0.4747	0.612
324	0.4657	0.603
325	0.4581	0.596
326	0.452	0.59
327	0.4474	0.585
328	0.4443	0.582
329	0.4427	0.581
330	0.4966	0.634
331	0.4786	0.617
332	0.4619	0.602
333	0.4463	0.587
334	0.4318	0.574
335	0.4184	0.561
336	0.4061	0.55
337	0.3949	0.539
338	0.3848	0.53
339	0.3756	0.521
340	0.3676	0.514
341	0.3605	0.507
342	0.3544	0.501
343	0.3493	0.496
344	0.3453	0.492
345	0.3422	0.489
346	0.3401	0.487

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Table F.8 – continued from previous page

Bus No.	Q_{wg} (Case I)	Q_{wg} (Case II)
347	0.3389	0.486
379	-0.3156	-0.196
380	-0.3209	-0.2
381	-0.3253	-0.204
382	-0.329	-0.207
383	-0.3318	-0.209
384	-0.3338	-0.211
385	-1.008	-0.932
386	-1.008	-0.932
387	-0.2913	-0.17
388	-0.2955	-0.173
389	-0.2992	-0.176
390	-0.3023	-0.178
391	-0.3048	-0.18
392	-0.3068	-0.182
393	-0.3082	-0.183
394	-0.5747	-0.45
395	-1.0061	-0.877
396	-1.0065	-0.877
397	-1.006	-0.877
398	-0.9759	-0.869

Table F.9: **Optimal excitation settings of synchronous generators (in p.u.)**

Bus No.	V_t (Case I)	V_t (Case II)
1	1.0252	1.0307
2	1.0262	1.0282
3	1.0146	1.0184

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Table F.9 – continued from previous page

Bus No.	V_t (Case I)	V_t (Case II)
4	1.0229	1.0277
5	1.0244	1.0307
6	1.0326	1.0377
7	1.009	1.0141
8	1.0204	1.0254
9	1.04	1.0426
10	1.04	1.045

Table F.10: **Optimal SVC settings (in MVAR)**

Bus No.	Q_{svc} (Case I)	Q_{svc} (Case II)
44	14	14
59	29	29
70	29	29
72	29	26
73	13	0
77	14	14
81	9	9
168	9	9
169	9	9
170	9	10
171	9	9
172	9	9