Wind Turbine Power Curves

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This working paper collates data on the power curves for 16 recent and forthcoming models of wind turbine from four major manufacturers: Siemens, Vestas, REpower and Nordex. The models chosen including 9 of the 10 most commonly used turbines in the UK, covering 70% of the installed capacity to date (4.7 GW of 6.6 GW).

These power curves were collected from manufacturer's data sheets, and are first presented in their native form: measured against wind speeds in m/s. For convenience, the power curves are also given against speeds in other units: km/h, mph and knots. These curves were translated to integer speed values – for example 22 mph instead of 22.369 mph (= 10 m/s) – using cubic spline interpolation, so as to minimise conversion errors.

If power curves were given for different air densities, 1.2 kg/m^3 was chosen, based on 1.225 kg/m^3 at sea-level and 15°C, reduced by a factor of 2.5% for 200 m elevation (typical land height in the UK plus 75 m for the hub).

Table 1: Summary statistics for the sixteen turbine models, indicating their suitability for on- and off-shore use. Ranking is based on the total installed capacity in the UK as of 2012, based on BWEA data [1].

Manufacturer	Model	Power (MW)	Diameter (m)	UK Rank	Capacity (MW)	On-shore	Off-shore	Data Source
Siemens	SWT 2.3	2.3	82	1	1,349	X	X	[2]
Siemens	SWT 2.3	2.3	93			X	X	[2]
Siemens	SWT 3.6	3.6	107	3	562	X		[2]
Vestas	V34	0.4	34	6	366	X		[2]
Vestas	V80	2.0	80	11	148	X		[3]
Vestas	V90	3.0	90	2	833	X	X	[4]
Vestas	V112	3.0	112	~		X	X	[5]
Vestas	V164	7.0	164	~		X	X	[6]
REpower	MM82	2.0	82	5	385	X		[7]
REpower	MM92	2.0	92	8	238	X		[8]
REpower	5M	5.0		~		X	X	[9]
REpower	6M	6.0		~		X	X	[9]
Nordex	N60	1.3	60	10	183	X		[10]
Nordex	N80	2.5	80	9	238	X		[11]
Nordex	N90	2.3	90	7	257	X	X	[11]
Nordex	N100	2.5	100	~		X	X	[12]

Figure 1: Wind turbine power curves for sixteen models (left), normalised against maximum output (right).

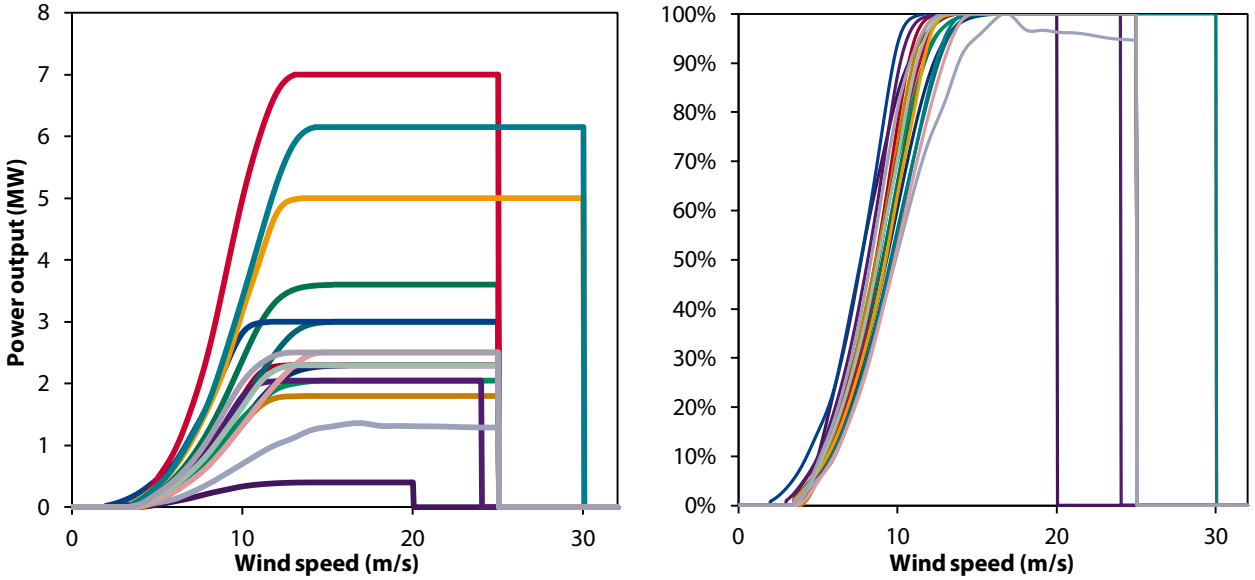

Table 2: Wind turbine power curves – wind turbine power output against wind speed in metres per second.

Speed (m/s)	Siemens SWT-2.3 82	Siemens SWT-2.3 93	Siemens SWT-3.6 107	Vestas V34	Vestas V80	Vestas V90	Vestas V112	Vestas V164	Repower MM82	Repower MM92	Repower 5M	Repower 6M	Nordex N60	Nordex N80	Nordex N90	Nordex N100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	104	0	0	20	0	0	0	0	0	0
4	42	98	80	4	2	75	244	101	64	94	141	120	29	15	35	50
5	136	210	238	40	97	187	451	461	159	205	343	343	73	121	175	221
6	276	376	474	93	255	348	709	902	314	391	636	666	131	251	352	431
7	470	608	802	150	459	574	1162	1595	511	645	1067	1135	241	433	580	720
8	727	914	1234	220	726	875	1666	2513	767	979	1615	1695	376	667	870	1102
9	1043	1312	1773	280	1004	1257	2269	3737	1096	1375	2289	2496	536	974	1237	1575
10	1394	1784	2379	335	1330	1688	2817	4988	1439	1795	3166	3389	704	1319	1623	2019
11	1738	2164	2948	368	1627	2118	2980	5987	1700	2000	3984	4328	871	1675	2012	2304
12	2015	2284	3334	387	1772	2514	3000	6698	1912	2040	4748	5231	1016	2004	2230	2458
13	2183	2299	3515	397	1797	2817	3000	6984	2000	2050	4978	5872	1124	2281	2300	2500
14	2260	2300	3577	400	1802	2958	3000	6985	2040	2050	4999	6128	1247	2463	2300	2500
15	2288	2300	3594	400	1802	2994	3000	6995	2050	2050	5000	6150	1301	2500	2300	2500
16	2297	2300	3599	400	1802	2999	3000	6995	2050	2050	5000	6150	1344	2500	2300	2500
17	2299	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1364	2500	2300	2500
18	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1322	2500	2300	2500
19	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1319	2500	2300	2500
20	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1314	2500	2300	2500
21	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1312	2500	2300	2500
22	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1307	2500	2300	2500
23	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1299	2500	2300	2500
24	2300	2300	3600	0	1800	3000	3000	6995	2050	2050	5000	6150	1292	2500	2300	2500
25	2300	2300	3600	0	1800	3000	3000	6995	2050	0	5000	6150	1292	2500	2300	2500
26	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Wind turbine power curves – wind turbine power output against wind speed in kilometres per hour.

Speed (km/h)	SWT 2.3	SWT 2.3	SWT 3.6	V34	V80	V90	V112	V164	MM82	MM92	5M	6M	N60	N80	N90	N100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	81	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	143	0	0	39	0	0	0	0	0	0
14	35	85	67	2	0	64	225	77	55	84	121	101	25	9	26	38
16	78	146	141	16	32	121	331	240	101	137	224	209	48	54	87	115
18	136	210	238	40	97	187	451	461	159	205	343	343	73	121	175	221
20	208	294	359	69	180	269	576	687	238	299	490	505	100	190	269	332
22	295	399	506	99	275	370	750	965	334	416	677	712	141	268	374	458
24	399	523	682	130	384	491	998	1337	440	552	908	969	200	366	498	614
26	522	669	889	165	515	634	1271	1777	562	713	1180	1247	269	480	638	796
28	664	839	1128	205	665	801	1548	2283	704	899	1485	1553	344	609	798	1008
30	827	1036	1403	241	816	994	1857	2894	870	1103	1818	1938	427	762	986	1253
32	1006	1263	1709	274	971	1211	2199	3593	1057	1327	2202	2399	518	937	1195	1521
34	1197	1519	2039	306	1145	1446	2545	4311	1254	1573	2670	2887	610	1124	1406	1786
36	1394	1784	2379	335	1330	1688	2817	4988	1439	1795	3166	3389	704	1319	1623	2019
38	1590	2022	2710	356	1508	1929	2946	5577	1592	1938	3622	3907	798	1518	1850	2197
40	1773	2190	3002	371	1651	2164	2985	6082	1727	2010	4078	4433	889	1713	2046	2327
42	1934	2266	3230	382	1741	2389	3000	6503	1852	2035	4535	4947	973	1899	2178	2420
44	2062	2291	3390	390	1784	2593	3000	6798	1942	2043	4845	5404	1041	2071	2256	2475
46	2155	2300	3489	395	1796	2763	3000	6954	1988	2050	4961	5762	1099	2225	2293	2497
48	2217	2300	3544	399	1799	2881	3000	6995	2016	2050	4992	5997	1167	2356	2300	2500
50	2255	2300	3573	400	1802	2949	3000	6995	2037	2050	5000	6115	1236	2450	2300	2500
52	2276	2300	3587	400	1802	2982	3000	6995	2047	2050	5000	6150	1278	2492	2300	2500
54	2288	2300	3594	400	1802	2994	3000	6995	2050	2050	5000	6150	1301	2500	2300	2500
56	2294	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1325	2500	2300	2500
58	2297	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1349	2500	2300	2500
60	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1364	2500	2300	2500
62	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1357	2500	2300	2500
64	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1331	2500	2300	2500
66	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1317	2500	2300	2500
68	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1319	2500	2300	2500
70	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1318	2500	2300	2500
72	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1314	2500	2300	2500
74	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1313	2500	2300	2500
76	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1312	2500	2300	2500
78	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1309	2500	2300	2500
80	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1305	2500	2300	2500
82	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1301	2500	2300	2500
84	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1297	2500	2300	2500
86	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1294	2500	2300	2500
88	2300	2300	3600	0	1802	3000	3000	6995	2050	0	5000	6150	1293	2500	2300	2500
90	2300	2300	3600	0	1802	3000	3000	6995	2050	0	5000	6150	1292	2500	2300	2500
92	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
108	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4: Wind turbine power curves – wind turbine power output against wind speed in miles per hour.

Speed (mph)	SWT 2.3	SWT 2.3	SWT 3.6	V34	V80	V90	V112	V164	MM82	MM92	5M	6M	N60	N80	N90	N100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	118	0	0	27	0	0	0	0	0	0
8	18	49	35	0	0	36	176	30	31	57	68	53	13	0	9	16
9	44	101	83	4	3	77	248	107	66	96	145	124	30	16	37	53
10	80	149	145	17	35	124	337	250	104	140	229	214	49	57	91	120
11	126	199	222	36	86	176	433	428	149	193	324	321	69	111	161	205
12	182	262	314	59	150	239	530	607	209	264	436	445	90	166	236	293
13	246	340	423	83	222	313	647	804	281	351	571	594	117	224	316	387
14	321	430	549	107	302	400	811	1055	361	450	734	776	155	293	405	497
15	407	533	695	132	392	500	1017	1366	448	562	926	988	205	374	507	625
16	505	650	861	160	497	615	1237	1719	546	691	1144	1212	260	465	620	772
17	616	781	1048	192	616	745	1457	2111	656	837	1384	1448	319	565	744	937
18	741	930	1257	223	739	891	1692	2564	781	996	1643	1727	383	680	886	1123
19	877	1098	1488	251	860	1055	1953	3090	922	1165	1922	2066	453	811	1045	1329
20	1023	1286	1739	277	986	1233	2231	3660	1075	1349	2242	2444	526	954	1214	1546
21	1177	1492	2004	303	1126	1421	2511	4239	1234	1548	2619	2837	601	1105	1384	1760
22	1335	1706	2278	327	1275	1616	2750	4795	1387	1736	3021	3238	676	1261	1557	1955
23	1494	1911	2550	347	1423	1811	2899	5298	1520	1878	3402	3650	752	1420	1739	2116
24	1649	2084	2807	361	1558	2003	2963	5743	1634	1967	3761	4071	827	1580	1917	2242
25	1793	2203	3032	372	1665	2191	2987	6136	1742	2015	4134	4495	899	1736	2065	2340
26	1922	2262	3214	381	1736	2372	3000	6474	1843	2034	4502	4908	967	1885	2170	2414
27	2030	2287	3353	388	1776	2539	3000	6732	1922	2041	4783	5287	1024	2025	2239	2464
28	2115	2296	3449	393	1793	2688	3000	6896	1970	2046	4924	5608	1072	2155	2280	2490
29	2179	2300	3511	397	1797	2809	3000	6980	1998	2050	4976	5856	1120	2272	2300	2500
30	2223	2300	3550	399	1799	2893	3000	6995	2020	2050	4994	6020	1177	2372	2300	2500
31	2253	2300	3572	400	1802	2946	3000	6995	2036	2050	5000	6111	1233	2446	2300	2500
32	2272	2300	3585	400	1802	2976	3000	6995	2046	2050	5000	6150	1270	2486	2300	2500
33	2284	2300	3592	400	1802	2990	3000	6995	2050	2050	5000	6150	1292	2500	2300	2500
34	2291	2300	3595	400	1802	2996	3000	6995	2050	2050	5000	6150	1309	2500	2300	2500
35	2295	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1329	2500	2300	2500
36	2297	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1348	2500	2300	2500
37	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1364	2500	2300	2500
38	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1364	2500	2300	2500
39	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1348	2500	2300	2500
40	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1326	2500	2300	2500
41	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1317	2500	2300	2500
42	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1318	2500	2300	2500
43	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1319	2500	2300	2500
44	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1316	2500	2300	2500
45	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1313	2500	2300	2500
46	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1313	2500	2300	2500
47	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1312	2500	2300	2500
48	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1310	2500	2300	2500
49	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1308	2500	2300	2500
50	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1304	2500	2300	2500
51	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1301	2500	2300	2500
52	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1297	2500	2300	2500
53	2300	2300	3600	0	1802	3000	3000	6995	2050	2050	5000	6150	1295	2500	2300	2500
54	2300	2300	3600	0	1802	3000	3000	6995	2050	0	5000	6150	1294	2500	2300	2500
55	2300	2300	3600	0	1802	3000	3000	6995	2050	0	5000	6150	1293	2500	2300	2500
56	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5: Wind turbine power curves – wind turbine power output against wind speed in knots.

Speed (knots)	SWT 2.3	SWT 2.3	SWT 3.6	V34	V80	V90	V112	V164	MM82	MM92	5M	6M	N60	N80	N90	N100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	114	0	0	24	0	0	0	0	0	0
7	19	52	37	0	0	38	179	33	33	59	72	57	14	0	10	17
8	50	111	95	6	8	87	265	131	73	105	162	141	34	23	46	64
9	96	166	171	23	51	141	371	311	119	157	262	251	56	75	115	149
10	153	230	267	47	117	207	482	519	178	227	378	382	80	139	199	249
11	223	312	384	74	196	286	603	733	255	319	522	540	107	203	288	354
12	305	411	524	102	286	382	775	1002	345	430	701	739	146	278	387	474
13	403	528	689	131	388	496	1008	1353	445	557	918	979	202	371	503	620
14	517	663	881	164	509	628	1261	1760	557	707	1170	1237	267	476	633	789
15	648	819	1100	200	648	781	1516	2222	687	878	1450	1516	335	594	779	983
16	795	997	1350	235	789	957	1797	2773	837	1065	1754	1860	411	732	950	1206
17	958	1201	1627	265	930	1153	2108	3408	1007	1267	2096	2276	494	891	1140	1451
18	1132	1432	1927	295	1085	1366	2433	4074	1189	1491	2507	2724	579	1061	1335	1700
19	1314	1678	2241	324	1254	1589	2722	4722	1367	1712	2967	3183	666	1239	1533	1930
20	1497	1914	2554	347	1425	1814	2900	5306	1522	1880	3407	3657	753	1422	1742	2118
21	1674	2108	2847	363	1578	2035	2969	5811	1653	1977	3822	4141	839	1606	1945	2260
22	1836	2227	3094	375	1691	2250	2991	6251	1776	2023	4255	4628	921	1784	2103	2366
23	1976	2276	3285	384	1759	2452	3000	6606	1884	2038	4650	5091	995	1952	2206	2441
24	2086	2294	3417	391	1789	2634	3000	6844	1955	2044	4884	5493	1054	2107	2267	2482
25	2166	2300	3499	396	1796	2784	3000	6967	1993	2050	4969	5806	1108	2247	2296	2500
26	2220	2300	3547	399	1799	2888	3000	6995	2018	2050	4993	6010	1172	2365	2300	2500
27	2255	2300	3573	400	1802	2949	3000	6995	2037	2050	5000	6116	1236	2450	2300	2500
28	2275	2300	3587	400	1802	2980	3000	6995	2047	2050	5000	6150	1276	2491	2300	2500
29	2287	2300	3593	400	1802	2993	3000	6995	2050	2050	5000	6150	1298	2500	2300	2500
30	2293	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1319	2500	2300	2500
31	2297	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1342	2500	2300	2500
32	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1361	2500	2300	2500
33	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1364	2500	2300	2500
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36	2300	2300	3600	400	1802	3000	3000	6995	2050	2050	5000	6150	1317	2500	2300	2500
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57	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	5000	6150	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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