

**APPENDIX 8.4: COLLISION RISK (GOLDEN PLOVER)**

Input data	Symbol	Derivation	Flight activity zone					
			VP1	VP2	VP3	VP4	VP5	Overall
Collision risk for species (calculated separately; see Appendix 8.4b)	C		0.076	0.076	0.076	0.076	0.076	0.076
Avoidance rate	A		0.99	0.99	0.99	0.99	0.99	0.99
Mean length of species (m)	l		0.265	0.265	0.265	0.265	0.265	0.265
Mean flight speed of species (m/sec)	v		20	20	20	20	20	20
Mean depth of rotor, back to front (m)	d		2.359	2.359	2.359	2.359	2.359	2.359
Flight activity survey area (km <sup>2</sup> )	SA		0.8645	0.7855	1.1645	0.8355	1.0129	4.6629
No. turbines	N		2	5	4	7	4	22
Radius of rotor-sweep (m)	r		41	41	41	41	41	41
Height of 'middle flight-height' observed (m)	m		112	112	112	112	112	112
Time (bird-secs) species recorded flying 'middle flight-height'	t		314669	3237	56412	5627	10028	389973
No. hours observations undertaken when species present in area	h		120	120	120	120	120	600
Max No. potential hours pa species flying over site	p		7302	7302	7302	7302	7302	7302
Max proportion potential hours pa species likely flying (i.e. excluding bad weather)	pp		0.99	0.99	0.99	0.99	0.99	0.99
<b>Computations</b>								
Non-avoidance rate		1 - A	0.01	0.01	0.01	0.01	0.01	0.01
d + l		d + l	2.624	2.624	2.624	2.624	2.624	2.624
Flight risk volume (m <sup>3</sup> )	V <sub>w</sub>	SA x 1000 x 1000 x 2r	70889000	64411000	95489000	68511000	83057800	382357800
Combined volume swept out by rotors (m <sup>3</sup> )	V <sub>r</sub>	N x πr <sup>2</sup> x (d + l)	27725.93	69314.83	55451.87	97040.77	55451.87	304985.27
Estimated bird-secs flying within rotor-sweep height	F	t x 2r/m	230382.66	2369.95	41301.64	4119.77	7341.93	285515.95
Estimated bird-secs flying within rotor-sweep height per hour of observation	Fhr <sup>-1</sup>	F/h	1919.86	19.75	344.18	34.33	61.18	475.86
Bird occupancy pa within flight risk volume (secs)	Occ (V <sub>w</sub> )	Fhr <sup>-1</sup> x (p x pp)	13878597	142769	2488073	248181	442289	3439982
Bird occupancy pa of volume swept by rotors (secs)	Occ (V <sub>r</sub> )	Occ (V <sub>w</sub> ) x (V <sub>r</sub> /V <sub>w</sub> )	5428.16	153.64	1444.86	351.53	295.29	2743.88
Time taken for bird to fly through and clear rotors	T	d + l / v	0.13	0.13	0.13	0.13	0.13	0.13
No. bird transits pa	BT	Occ (V <sub>r</sub> ) / T	41373.20	1171.03	11012.66	2679.34	2250.65	20913.72
No. fatalities pa with no avoidance	F <sub>na</sub>	BT x C	3144.36	89.00	836.96	203.63	171.05	1589.44
No. fatalities pa	F	F <sub>na</sub> x (1 - A)	31.44	0.89	8.37	2.04	1.71	15.89

**CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA**

K: [1D or [3D] (0 or 1)	1	<b>Calculation of alpha and p(collision) as a function of radius</b>								
NoBlades	3				Upwind:			Downwind:		
MaxChord	4.14 m	r/R	c/C	$\alpha$	collide	contribution	collide	contribution		
Pitch (degrees)	5	radius	chord	alpha	length	p(collision)	length	p(collision)	from radius r	
BirdLength	0.265 m	0.025	0.575	15.53	48.13	1.00	47.72	1.00	0.00125	
Wingspan	0.715 m	0.075	0.575	5.18	16.18	0.49	15.77	0.47	0.00355	
F: Flapping (0) or gliding (+1)	0	0.125	0.702	3.11	11.46	0.34	10.95	0.33	0.00411	
		0.175	0.860	2.22	9.76	0.29	9.14	0.27	0.00480	
Bird speed	20 m/sec	0.225	0.994	1.73	8.67	0.26	7.95	0.24	0.00537	
RotorDiam	82 m	0.275	0.947	1.41	6.86	0.21	6.18	0.19	0.00510	
RotationPeriod	5.00 sec	0.325	0.899	1.19	5.61	0.17	4.96	0.15	0.00483	
		0.375	0.851	1.04	4.68	0.14	4.07	0.12	0.00458	
		0.425	0.804	0.91	3.97	0.12	3.39	0.10	0.00432	
		0.475	0.756	0.82	3.40	0.10	2.86	0.09	0.00407	
Bird aspect ratio: $\beta$	0.37	0.525	0.708	0.74	2.94	0.09	2.43	0.07	0.00383	
		0.575	0.660	0.68	2.56	0.08	2.08	0.06	0.00359	
		0.625	0.613	0.62	2.23	0.07	1.79	0.05	0.00336	
		0.675	0.565	0.58	1.96	0.06	1.55	0.05	0.00313	
		0.725	0.517	0.54	1.71	0.05	1.34	0.04	0.00291	
		0.775	0.470	0.50	1.50	0.04	1.16	0.03	0.00269	
		0.825	0.422	0.47	1.31	0.04	1.00	0.03	0.00248	
		0.875	0.374	0.44	1.14	0.03	0.87	0.03	0.00228	
		0.925	0.327	0.42	0.98	0.03	0.75	0.02	0.00207	
		0.975	0.279	0.40	0.84	0.03	0.64	0.02	0.00188	
Overall p(collision) =					Upwind	8.2%	Downwind	7.0%		
					Average	7.6%				