

# Compliance with the RF Exposure Limitations for the KHDD-1000C

Peak Power = 1.25MW (WORST CASE)  
Pulse Width = 4.5 us  
Pulse Repetition Frequency = 333 Hz  
Average Power (P) = 1862 W  
Wavelength ( $\lambda$ ) = 5.36 cm (C-Band Wavelength)  
Reflector Diameter (D) = 3.7 m  
Reflector Surface Area (A) = 10.8 m square  
Reflector Isotropic Gain = 44.7 dBi

Given that the above parameters are fixed, meaning that the pulse width and PRF are the calculated maximum duty cycle of .0015%, the power density is a function of range and location with regard to the axis of the main beam. The power density is greatest along the main beam axis, so all calculations will be made for this condition.

Three different methods are used to estimate power density, depending on whether the point of interest is in the near-field region, the transition region, or the far-field region of the antenna. For  $\lambda = 5.36$  cm, the near field region extends to 63.8 m (209.3 ft), the transition region extends to 153.2 m (502.6 ft) and the far-field region extends from this point.

$$R_{nf} = D^2 / 4\lambda \quad \text{or} \quad 63.8 \text{ meters}$$
$$R_{ff} = 0.6 D^2 / \lambda \quad \text{or} \quad 153.2 \text{ meters}$$

Within the near-field region the power density can reach a maximum of 87.133 mw/cm<sup>2</sup>.

The power density decreases inversely with the distance from the antenna within the transition region. At the start of the transition region the power density is 87.133 mw/cm<sup>2</sup>. Near the end, (153.2 m) the power density is 14.733 mw/cm<sup>2</sup>.

Beyond 153.2 m (502.6 ft), the power density can be calculated as follows.

$$S = PG / (4\pi R^2)$$

Where S is power density, P is power, G is antenna gain and R is distance from the antenna.

Utilizing this equation, we can solve for the distance at which the power density is below the FCC controlled exposure limit of  $5 \text{ mw/cm}^2$ . This distance is 264 m (792 ft). We can also solve for the distance at which the power density is below the FCC uncontrolled exposure limit of  $1 \text{ mw/cm}^2$ . This distance is 547.3 m (1770 ft)

If the point of interest is beyond 1770 ft, then the power density is such that it is below the uncontrolled exposure limit. **This is even if the point of interest remains on-axis at all times because the antenna is not rotating.**

If the point of interest is at least one antenna diameter (3.7m) off-axis within the near field or transition region, the power density is at least a factor of 100 less than the values calculated above. The tower height should be such that the main beam is 10m above ground level at 200m distance when the main beam is pointing 1 degree below the horizon. Therefore, the tower should be at a minimum:

$$10\text{m} + 3.5\text{m} + 3.7\text{m} = 17\text{m} \text{ (55.7 ft)}$$

At this height, all points along the ground (near-field included) will have a power density below the FCC controlled limit of  $5 \text{ mw/cm}^2$ .

One item not considered is that exposure limits may be averaged (6 minutes for controlled access and 30 for uncontrolled access.) The fact that the antenna is rotating and a fix point of interest is on-axis for only a brief period of time (factor of .0027), greatly reduces the average power density. Thus, **all** points of interest not on the antenna surface are below both exposure limits while the antenna is rotating.

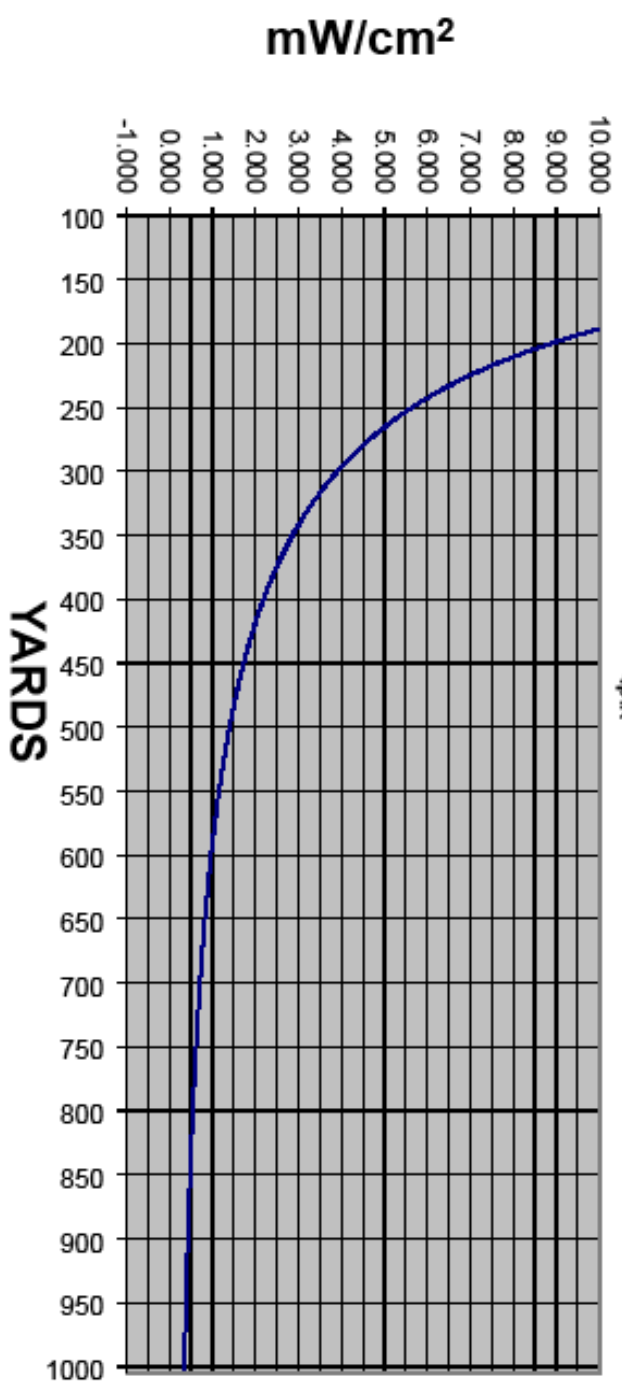
Example: 30 minute exposure within 1770 ft (uncontrolled access limit) factored by .0027 = .081 (4.86 seconds) exposure time.

In conclusion, a radar system with the above characteristics can be within compliance with FCC exposure limit guidelines by mounting the antenna 60ft or higher above any occurred areas within 200 ft of the antenna.

Tx Average Power (dBm)	62.7	dBm	Antenna Gain	44.7	dB	RADAR #	KHDD-1000DP
Transmission Loss (dB)	1.8	dB	Start Range	100	Yards	ERP	36.31 Gigawatts Pulse
Power @ Antenna	60.9	dBm	Plot Every	5	Yards	ERP	36.31 Mwatts Ave
OET 65, Supplement B (Edition 97-01)			Controlled Access - 6 minute average exposure			Rad Hazard Minimum Distance	
Pulsed Radar Calculations			Uncontrolled Access - 30 minute average exposure			5mW/cm <sup>2</sup>	789.0 feet
						1mW/cm <sup>2</sup>	1764.2 feet

## On-Axis RF Power Density

$$\frac{P_G}{4\pi R^2}$$



Numbers used for the On-Axis RF Power Density chart

<b>meters</b>	<b>yards</b>	<b>ft</b>	<b>cm</b>	<b>mW/cm<sup>2</sup></b>
91.46	100	300	9144	34.583
96.46	105	315	9601	31.368
101.46	110	330	10058	28.581
106.46	115	345	10516	26.150
111.46	120	360	10973	24.016
116.46	125	375	11430	22.133
121.46	130	390	11887	20.463
126.46	135	405	12344	18.976
131.46	140	420	12802	17.644
136.46	145	435	13259	16.449
141.46	150	450	13716	15.370
146.46	155	465	14173	14.395
151.46	160	480	14630	13.509
156.46	165	495	15088	12.703
161.46	170	510	15545	11.966
166.46	175	525	16002	11.292
171.46	180	540	16459	10.674
176.46	185	555	16916	10.105
181.46	190	570	17374	9.580
186.46	195	585	17831	9.095
191.46	200	600	18288	8.646
196.46	205	615	18745	8.229
201.46	210	630	19202	7.842
206.46	215	645	19660	7.481
211.46	220	660	20117	7.145
216.46	225	675	20574	6.831
221.46	230	690	21031	6.537
226.46	235	705	21488	6.262
231.46	240	720	21946	6.004
236.46	245	735	22403	5.761
241.46	250	750	22860	5.533
246.46	255	765	23317	5.318
251.46	260	780	23774	5.116
256.46	265	795	24232	4.925
261.46	270	810	24689	4.744
266.46	275	825	25146	4.573
271.46	280	840	25603	4.411
276.46	285	855	26060	4.258
281.46	290	870	26518	4.112
286.46	295	885	26975	3.974
291.46	300	900	27432	3.843
296.46	305	915	27889	3.718
301.46	310	930	28346	3.599
306.46	315	945	28804	3.485
311.46	320	960	29261	3.377

<b>meters</b>	<b>yards</b>	<b>ft</b>	<b>cm</b>	<b>mW/cm<sup>2</sup></b>
316.46	325	975	29718	3.274
321.46	330	990	30175	3.176
326.46	335	1005	30632	3.082
331.46	340	1020	31090	2.992
336.46	345	1035	31547	2.906
341.46	350	1050	32004	2.823
346.46	355	1065	32461	2.744
351.46	360	1080	32918	2.668
356.46	365	1095	33376	2.596
361.46	370	1110	33833	2.526
366.46	375	1125	34290	2.459
371.46	380	1140	34747	2.395
376.46	385	1155	35204	2.333
381.46	390	1170	35662	2.274
386.46	395	1185	36119	2.217
391.46	400	1200	36576	2.161
396.46	405	1215	37033	2.108
401.46	410	1230	37490	2.057
406.46	415	1245	37948	2.008
411.46	420	1260	38405	1.960
416.46	425	1275	38862	1.915
421.46	430	1290	39319	1.870
426.46	435	1305	39776	1.828
431.46	440	1320	40234	1.786
436.46	445	1335	40691	1.746
441.46	450	1350	41148	1.708
446.46	455	1365	41605	1.670
451.46	460	1380	42062	1.634
456.46	465	1395	42520	1.599
461.46	470	1410	42977	1.566
466.46	475	1425	43434	1.533
471.46	480	1440	43891	1.501
476.46	485	1455	44348	1.470
481.46	490	1470	44806	1.440
486.46	495	1485	45263	1.411
491.46	500	1500	45720	1.383
496.46	505	1515	46177	1.356
501.46	510	1530	46634	1.330
506.46	515	1545	47092	1.304
511.46	520	1560	47549	1.279
516.46	525	1575	48006	1.255
521.46	530	1590	48463	1.231
526.46	535	1605	48920	1.208
531.46	540	1620	49378	1.186
536.46	545	1635	49835	1.164
541.46	550	1650	50292	1.143
546.46	555	1665	50749	1.123

<b>meters</b>	<b>yards</b>	<b>ft</b>	<b>cm</b>	<b>mW/cm<sup>2</sup></b>
551.46	560	1680	51206	1.103
556.46	565	1695	51664	1.083
561.46	570	1710	52121	1.064
566.46	575	1725	52578	1.046
571.46	580	1740	53035	1.028
576.46	585	1755	53492	1.011
581.46	590	1770	53950	0.993
586.46	595	1785	54407	0.977
591.46	600	1800	54864	0.961
596.46	605	1815	55321	0.945
601.46	610	1830	55778	0.929
606.46	615	1845	56236	0.914
611.46	620	1860	56693	0.900
616.46	625	1875	57150	0.885
621.46	630	1890	57607	0.871
626.46	635	1905	58064	0.858
631.46	640	1920	58522	0.844
636.46	645	1935	58979	0.831
641.46	650	1950	59436	0.819
646.46	655	1965	59893	0.806
651.46	660	1980	60350	0.794
656.46	665	1995	60808	0.782
661.46	670	2010	61265	0.770
666.46	675	2025	61722	0.759
671.46	680	2040	62179	0.748
676.46	685	2055	62636	0.737
681.46	690	2070	63094	0.726
686.46	695	2085	63551	0.716
691.46	700	2100	64008	0.706
696.46	705	2115	64465	0.696
701.46	710	2130	64922	0.686
706.46	715	2145	65380	0.676
711.46	720	2160	65837	0.667
716.46	725	2175	66294	0.658
721.46	730	2190	66751	0.649
726.46	735	2205	67208	0.640
731.46	740	2220	67666	0.632
736.46	745	2235	68123	0.623
741.46	750	2250	68580	0.615
746.46	755	2265	69037	0.607
751.46	760	2280	69494	0.599
756.46	765	2295	69952	0.591
761.46	770	2310	70409	0.583
766.46	775	2325	70866	0.576
771.46	780	2340	71323	0.568
776.46	785	2355	71780	0.561
781.46	790	2370	72238	0.554

<b>meters</b>	<b>yards</b>	<b>ft</b>	<b>cm</b>	<b>mW/cm<sup>2</sup></b>
786.46	795	2385	72695	0.547
791.46	800	2400	73152	0.540
796.46	805	2415	73609	0.534
801.46	810	2430	74066	0.527
806.46	815	2445	74524	0.521
811.46	820	2460	74981	0.514
816.46	825	2475	75438	0.508
821.46	830	2490	75895	0.502
826.46	835	2505	76352	0.496
831.46	840	2520	76810	0.490
836.46	845	2535	77267	0.484
841.46	850	2550	77724	0.479
846.46	855	2565	78181	0.473
851.46	860	2580	78638	0.468
856.46	865	2595	79096	0.462
861.46	870	2610	79553	0.457
866.46	875	2625	80010	0.452
871.46	880	2640	80467	0.447
876.46	885	2655	80924	0.442
881.46	890	2670	81382	0.437
886.46	895	2685	81839	0.432
891.46	900	2700	82296	0.427
896.46	905	2715	82753	0.422
901.46	910	2730	83210	0.418
906.46	915	2745	83668	0.413
911.46	920	2760	84125	0.409
916.46	925	2775	84582	0.404
921.46	930	2790	85039	0.400
926.46	935	2805	85496	0.396
931.46	940	2820	85954	0.391
936.46	945	2835	86411	0.387
941.46	950	2850	86868	0.383
946.46	955	2865	87325	0.379
951.46	960	2880	87782	0.375
956.46	965	2895	88240	0.371
961.46	970	2910	88697	0.368
966.46	975	2925	89154	0.364
971.46	980	2940	89611	0.360
976.46	985	2955	90068	0.356
981.46	990	2970	90526	0.353
986.46	995	2985	90983	0.349
991.46	1000	3000	91440	0.346