SATELLITE OUTAGE ANALYSIS RESULTS

	EPFD Satellite @ 101 Deg. WL		EPFD Satellite @ 110 Deg. WL		EPFD Satellite @ 119 Deg. WL		Average EPFD		Regional Average EPFD
	dBW/m²	W/m²	dBW/m²	W/m²	DBW/m²	W/m²	W/m²	dBW/m²	dBW/m²
	Reference Bandwidth = 4 kHz								
Greenville	-165.7	2.6915E-17	-168.6	1.3804E-17	-169.3	1.1749E-17	1.7489E-17	-167.6	-168.4
Charlotte	-165.9	2.5704E-17	-168.8	1.3183E-17	-169.6	1.0965E-17	1.6617E-17	-167.8	-168.4
Miami	-167.9	1.6218E-17	-168.1	1.5488E-17	-168.6	1.3804E-17	1.5170E-17	-168.2	-168.4
Tampa	-168.1	1.5488E-17	-168.2	1.5136E-17	-168.8	1.3183E-17	1.4602E-17	-168.4	-168.4
Orlando	-168.2	1.5136E-17	-168.2	1.5136E-17	-168.9	1.2882E-17	1.4385E-17	-168.4	-168.4
Washington DC	-166.1	2.4547E-17	-171.9	6.4565E-18	-169.5	1.1220E-17	1.4075E-17	-168.5	-168.4
Columbus	-166.1	2.4547E-17	-172.1	6.1660E-18	-169.5	1.1220E-17	1.3978E-17	-168.5	-168.4
Pittsburgh	-166.2	2.3988E-17	-172.2	6.0256E-18	-169.8	1.0471E-17	1.3495E-17	-168.7	-168.4
Philadelphia	-166.3	2.3442E-17	-172.0	6.3096E-18	-169.7	1.0715E-17	1.3489E-17	-168.7	-168.4
New York	-166.3	2.3442E-17	-172.2	6.0256E-18	-169.6	1.0965E-17	1.3478E-17	-168.7	-168.4
Atlanta	-168.4	1.4454E-17	-168.6	1.3804E-17	-169.3	1.1749E-17	1.3336E-17	-168.7	-168.4
Boston	-166.5	2.2387E-17	-172.4	5.7544E-18	-170.0	1.0000E-17	1.2714E-17	-169.0	-168.4
Houston	-168.3	1.4791E-17	-171.2	7.5858E-18	-168.9	1.2882E-17	1.1753E-17	-169.3	-169.8
Dallas	-168.4	1.4454E-17	-171.4	7.2444E-18	-169.0	1.2589E-17	1.1429E-17	-169.4	-169.8
Cincinnati	-168.6	1.3804E-17	-171.8	6.6069E-18	-169.4	1.1482E-17	1.0631E-17	-169.7	-169.8
Indianapolis	-168.6	1.3804E-17	-171.7	6.7608E-18	-169.5	1.1220E-17	1.0595E-17	-169.7	-169.8
St. Louis	-168.7	1.3490E-17	-171.7	6.7608E-18	-169.5	1.1220E-17	1.0490E-17	-169.8	-169.8
Nashville	-168.7	1.3490E-17	-171.8	6.6069E-18	-169.5	1.1220E-17	1.0439E-17	-169.8	-169.8
Kansas City	-168.6	1.3804E-17	-171.6	6.9183E-18	-169.4	1.1482E-17	1.0735E-17	-169.7	-169.8
Chicago	-168.8	1.3183E-17	-171.9	6.4565E-18	-169.7	1.0715E-17	1.0118E-17	-169.9	-169.8
Milwaukee	-168.9	1.2882E-17	-171.9	6.4565E-18	-169.7	1.0715E-17	1.0018E-17	-170.0	-169.8
Detroit	-168.9	1.2882E-17	-172.2	6.0256E-18	-169.6	1.0965E-17	9.9576E-18	-170.0	-169.8
Minneapolis	-169.0	1.2589E-17	-171.9	6.4565E-18	-169.7	1.0715E-17	9.9203E-18	-170.0	-169.8
Cleveland	-169.0	1.2589E-17	-172.1	6.1660E-18	-169.7	1.0715E-17	9.8235E-18	-170.1	-169.8
Phoenix	-171.5	7.0795E-18	-171.6	6.9183E-18	-169.5	1.1220E-17	8.4060E-18	-170.8	-171.0
San Diego	-169.1	1.2303E-17	-172.0	6.3096E-18	-172.5	5.6234E-18	8.0786E-18	-170.9	-171.0
Los Angeles	-169.2	1.2023E-17	-172.0	6.3096E-18	-172.4	5.7544E-18	8.0289E-18	-171.0	-171.0
Denver	-172.4	5.7544E-18	-172.3	5.8884E-18	-170.1	9.7724E-18	7.1384E-18	-171.5	-171.0
Sacramento	-171.6	6.9183E-18	-171.8	6.6069E-18	-172.4	5.7544E-18	6.4265E-18	-171.9	-172.1
San Francisco	-171.9	6.4565E-18	-171.7	6.7608E-18	-172.5	5.6234E-18	6.2803E-18	-172.0	-172.1
Portland	-171.9	6.4565E-18	-172.3	5.8884E-18	-172.6	5.4954E-18	5.9468E-18	-172.3	-172.1
Seattle	-171.9	6.4565E-18	-172.3	5.8884E-18	-172.7	5.3703E-18	5.9051E-18	-172.3	-172.1

	Regional Average EPFD	Satellite @ 101 Deg. WL		Satellite @ 110 Deg. WL		Satellite @ 119 Deg. WL	
	dBW/m2/4kHz	EPFD (dBW/m2/4kHz)	Difference from Regional Average (dB)	EPFD (dBW/m2/4kHz)	Difference from Regional Average (dB)	EPFD (dBW/m2/4kHz)	Difference from Regional Average (dB)
Greenville	-168.4	-165.7	2.7	-168.6	-0.2	-169.3	-0.9
Charlotte	-168.4	-165.9	2.5	-168.8	-0.4	-169.6	-1.2
Miami	-168.4	-167.9	0.5	-168.1	0.3	-168.6	-0.2
Tampa	-168.4	-168.1	0.3	-168.2	0.2	-168.8	-0.4
Orlando	-168.4	-168.2	0.2	-168.2	0.2	-168.9	-0.5
Washington DC	-168.4	-166.1	2.3	-171.9	-3.5	-169.5	-1.1
Columbus	-168.4	-166.1	2.3	-172.1	-3.7	-169.5	-1.1
Pittsburgh	-168.4	-166.2	2.2	-172.2	-3.8	-169.8	-1.4
Philadelphia	-168.4	-166.3	2.1	-172.0	-3.6	-169.7	-1.3
New York	-168.4	-166.3	2.1	-172.2	-3.8	-169.6	-1.2
Atlanta	-168.4	-168.4	0.0	-168.6	-0.2	-169.3	-0.9
Boston	-168.4	-166.5	1.9	-172.4	-4.0	-170.0	-1.6
Houston	-169.8	-168.3	1.5	-171.2	-1.4	-168.9	0.9
Dallas	-169.8	-168.4	1.4	-171.4	-1.6	-169.0	0.8
Cincinnati	-169.8	-168.6	1.2	-171.8	-2.0	-169.4	0.4
Indianapolis	-169.8	-168.6	1.2	-171.7	-1.9	-169.5	0.3
St. Louis	-169.8	-168.7	1.1	-171.7	-1.9	-169.5	0.3
Nashville	-169.8	-168.7	1.1	-171.8	-2.0	-169.5	0.3
Kansas City	-169.8	-168.6	1.2	-171.6	-1.8	-169.4	0.4
Chicago	-169.8	-168.8	1.0	-171.9	-2.1	-169.7	0.1
Milwaukee	-169.8	-168.9	0.9	-171.9	-2.1	-169.7	0.1
Detroit	-169.8	-168.9	0.9	-172.2	-2.4	-169.6	0.2
Minneapolis	-169.8	-169.0	0.8	-171.9	-2.1	-169.7	0.1
Cleveland	-169.8	-169.0	0.8	-172.1	-2.3	-169.7	0.1
Phoenix	-171.0	-171.5	-0.5	-171.6	-0.6	-169.5	1.5
San Diego	-171.0	-169.1	1.9	-172.0	-1.0	-172.5	-1.5
Los Angeles	-171.0	-169.2	1.8	-172.0	-1.0	-172.4	-1.4
Denver	-171.0	-172.4	-1.4	-172.3	-1.3	-170.1	0.9
Sacramento	-172.1	-171.6	0.5	-171.8	0.3	-172.4	-0.3
San Francisco	-172.1	-171.9	0.2	-171.7	0.4	-172.5	-0.4
Portland	-172.1	-171.9	0.2	-172.3	-0.2	-172.6	-0.5
Seattle	-172.1	-171.9	0.2	-172.3	-0.2	-172.7	-0.6

Results for the Satellite at 101 Degrees West Longitude						
	Baseline Outage (Due to rain)		New Outage (Rain plus MVDDS) Based on Regional Average EPFD		Difference in Outage	
	Minutes	Percent Availability	Minutes	Percent Availability	Minutes	Percent
Greenville	387.6	99.9263	408.7	99.9223	21.1	5.4
Charlotte	288.6	99.9451	304.6	99.9421	16.0	5.5
Miami	1720.3	99.6729	1873.0	99.6439	152.7	8.9
Tampa	1427.0	99.7287	1567.0	99.7021	140.0	9.8
Orlando	1480.4	99.7185	1626.0	99.6908	145.6	9.8
Washington DC	220.4	99.9581	233.1	99.9557	12.7	5.8
Columbus	203.1	99.9614	210.8	99.9599	7.7	3.8
Pittsburgh	168.8	99.9679	178.7	99.9660	9.9	5.9
Philadelphia	221.4	99.9579	238.5	99.9547	17.1	7.7
New York	200.1	99.9620	211.9	99.9597	11.8	5.9
Atlanta	866.0	99.8353	952.0	99.8190	86.0	9.9
Boston	163.7	99.9689	174.5	99.9668	10.8	6.6
Houston	1040.9	99.8021	1114.0	99.7882	73.1	7.0
Dallas	820.4	99.8440	879.9	99.8327	59.5	7.3
Cincinnati	469.1	99.9108	505.8	99.9038	36.7	7.8
Indianapolis	466.8	99.9112	477.3	99.9092	10.5	2.3
St. Louis	482.0	99.9084	519.3	99.9013	37.3	7.7
Nashville	552.8	99.8949	609.7	99.8841	56.9	10.3
Kansas City	425.1	99.9192	458.2	99.9129	33.1	7.8
Chicago	326.9	99.9378	353.4	99.9328	26.5	8.1
Milwaukee	311.3	99.9408	336.7	99.9360	25.4	8.2
Detroit	302.5	99.9425	327.4	99.9378	24.9	8.2
Minneapolis	303.3	99.9423	328.2	99.9376	24.9	8.2
Cleveland	369.9	99.9297	402.3	99.9235	32.4	8.8
Phoenix	661.5	99.8742	743.2	99.8587	81.7	12.4
San Diego	132.0	99.9749	140.4	99.9733	8.4	6.4
Los Angeles	82.2	99.9844	87.7	99.9833	5.5	6.7
Denver	148.6	99.9717	171.6	99.9674	23.0	15.5
Sacramento	766.9	99.8542	838.3	99.8406	71.4	9.3
San Francisco	653.9	99.8757	722.4	99.8626	68.5	10.5
Portland	571.1	99.8914	627.7	99.8807	56.6	9.9
Seattle	741.0	99.8591	813.9	99.8453	72.9	9.8

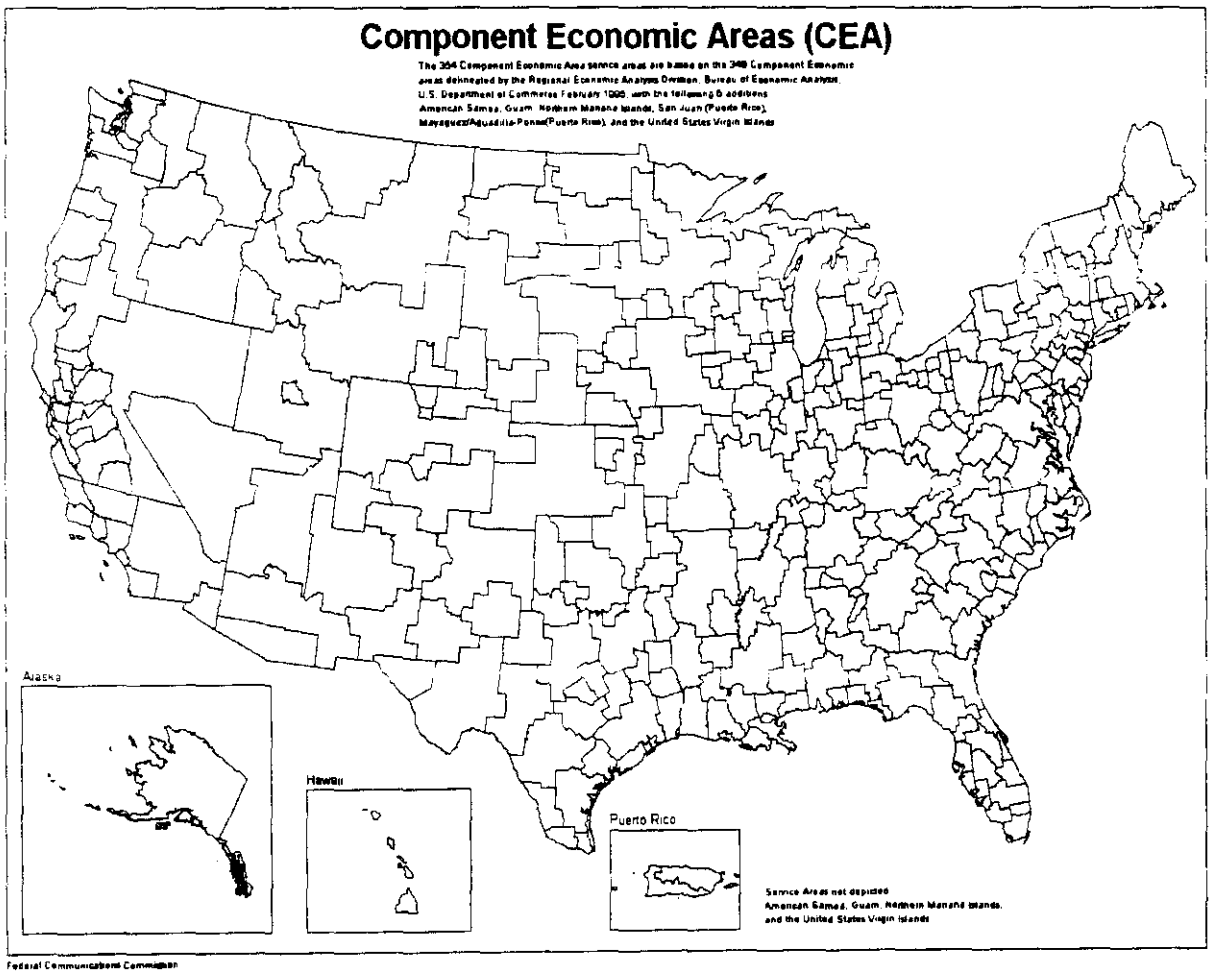
Results for the Satellite at 110 Degrees West Longitude						
	Baseline Outage (Due to rain)		New Outage (Rain plus MVDDS) Based on Regional Average EPFD		Difference in Outage	
	Minutes	Percent Availability	Minutes	Percent Availability	Minutes	Percent
Greenville	900.6	99.8288	999.6	99.8099	99.0	11.0
Charlotte	692.1	99.8684	779.3	99.8518	87.2	12.6
Miami	1930.3	99.6330	2117.0	99.5975	186.7	9.7
Tampa	1597.9	99.6962	1748.0	99.6676	150.1	9.4
Orlando	1668.4	99.6828	1836.0	99.6509	167.6	10.0
Washington DC	1388.3	99.7360	1765.0	99.6644	376.7	27.1
Columbus	1227.5	99.7666	1459.1	99.7226	231.6	18.9
Pittsburgh	1075.8	99.7955	1371.0	99.7393	295.2	27.4
Philadelphia	1429.0	99.7283	1842.0	99.6498	413.0	28.9
New York	1323.6	99.7483	1692.0	99.6783	368.4	27.8
Atlanta	976.1	99.8144	1082.0	99.7943	105.9	10.8
Boston	1156.8	99.7801	1506.5	99.7136	349.7	30.2
Houston	2476.2	99.5292	2832.0	99.4615	355.8	14.4
Dallas	2016.3	99.6166	2329.0	99.5572	312.7	15.5
Cincinnati	1324.0	99.7483	1554.4	99.7045	230.4	17.4
Indianapolis	1309.4	99.7510	1464.0	99.7216	154.6	11.8
St. Louis	1308.5	99.7512	1426.0	99.7289	117.5	9.0
Nashville	1504.4	99.7140	1850.1	99.6482	345.7	23.0
Kansas City	1134.8	99.7842	1329.7	99.7472	194.9	17.2
Chicago	936.4	99.8220	1105.0	99.7899	168.6	18.0
Milwaukee	898.8	99.8291	1061.9	99.7981	163.1	18.1
Detroit	899.4	99.8290	1075.0	99.7956	175.6	19.5
Minneapolis	853.6	99.8377	1009.0	99.8082	155.4	18.2
Cleveland	1094.9	99.7918	1306.0	99.7517	211.1	19.3
Phoenix	661.9	99.8742	744.6	99.8584	82.7	12.5
San Diego	334.4	99.9364	378.9	99.9280	44.5	13.3
Los Angeles	215.8	99.9590	245.6	99.9533	29.8	13.8
Denver	155.6	99.9704	178.1	99.9661	22.5	14.5
Sacramento	723.2	99.8625	798.9	99.8481	75.7	10.5
San Francisco	620.2	99.8821	678.8	99.8709	58.6	9.5
Portland	530.5	99.8991	589.6	99.8879	59.1	11.1
Seattle	689.0	99.8690	765.3	99.8545	76.3	11.1

Results for the Satellite at 119 Degrees West Longitude						
	Baseline Outage (Due to rain)		New Outage (Rain plus MVDDS) Based on Regional Average EPFD		Difference in Outage	
	Minutes	Percent Availability	Minutes	Percent Availability	Minutes	Percent
Greenville	1254.8	99.7614	1416.0	99.7308	161.2	12.8
Charlotte	995.7	99.8107	1134.0	99.7844	138.3	13.9
Miami	2614.1	99.5030	2899.0	99.4488	284.9	10.9
Tampa	2142.2	99.5927	2390.0	99.5456	247.8	11.6
Orlando	2255.1	99.5712	2516.0	99.5216	260.9	11.6
Washington DC	839.2	99.8404	954.0	99.8186	114.8	13.7
Columbus	708.7	99.8653	776.6	99.8523	67.9	9.6
Pittsburgh	628.3	99.8805	720.8	99.8629	92.5	14.7
Philadelphia	875.2	99.8336	1015.0	99.8070	139.8	16.0
New York	822.1	99.8437	943.6	99.8206	121.5	14.8
Atlanta	1331.7	99.7468	1510.0	99.7129	178.3	13.4
Boston	733.6	99.8605	844.5	99.8394	110.9	15.1
Houston	1380.0	99.7376	1496.0	99.7156	116.0	8.4
Dallas	1099.0	99.7910	1195.0	99.7728	96.0	8.7
Cincinnati	754.9	99.8565	826.3	99.8429	71.4	9.5
Indianapolis	661.5	99.8742	763.7	99.8548	102.2	15.4
St. Louis	717.4	99.8636	727.3	99.8617	9.9	1.4
Nashville	850.4	99.8383	954.7	99.8185	104.3	12.3
Kansas City	603.1	99.8853	659.6	99.8746	56.5	9.4
Chicago	513.4	99.9024	563.4	99.8929	50.0	9.7
Milwaukee	490.4	99.9068	538.6	99.8976	48.2	9.8
Detroit	511.7	99.9027	562.4	99.8931	50.7	9.9
Minneapolis	448.7	99.9147	492.9	99.9063	44.2	9.8
Cleveland	633.0	99.8796	694.7	99.8679	61.7	9.7
Phoenix	312.8	99.9405	335.4	99.9362	22.6	7.2
San Diego	418.4	99.9204	469.7	99.9107	51.3	12.3
Los Angeles	409.1	99.9222	469.7	99.9107	60.6	14.8
Denver	71.2	99.9865	77.2	99.9853	6.0	8.4
Sacramento	866.1	99.8353	967.3	99.8161	101.2	11.7
San Francisco	734.0	99.8604	820.3	99.8440	86.3	11.8
Portland	637.7	99.8788	717.6	99.8636	79.9	12.5
Seattle	828.1	99.8426	931.3	99.8229	103.2	12.5

Sample Results for the Satellite at 61.5 Degrees West Longitude						
	Baseline Outage (Due to rain)		New Outage (Rain plus MVDDS) Based on Regional Average EPFD		Difference in Outage	
	Minutes	Percent Availability	Minutes	Percent Availability	Minutes	Percent
Miami	804.2	99.8471	839.8	99.8403	35.6	4.4
Washington	177.8	99.9662	186.8	99.9645	9.0	5.0
New York	149.0	99.9717	157.4	99.9701	8.4	5.6
Kansas City	513.2	99.9024	548.1	99.8958	34.9	6.8
Detroit	276.1	99.9475	295.6	99.9438	19.5	7.1
Los Angeles	1616.0	99.6927	1792.0	99.6593	176.0	10.9
Seattle	9038.0	98.2816	11800.0	97.7564	2762.0	30.6

Sample Results for the Satellite at 148 Degrees West Longitude						
	Baseline Outage (Due to rain)		New Outage (Rain plus MVDDS) Based on Regional Average EPFD		Difference in Outage	
	Minutes	Percent Availability	Minutes	Percent Availability	Minutes	Percent
Seattle	8047.0	98.4700	9754.0	98.1454	1707.0	21.2
Portland	2054.0	99.6095	2640.0	99.4980	586.0	28.5
San Francisco	2619.0	99.5020	3294.0	99.3737	675.0	25.8
Los Angeles	396.0	99.9247	447.2	99.9150	51.2	12.9
Phoenix	355.0	99.9325	376.1	99.9285	21.1	5.9
Dallas	1962.0	99.6270	2110.0	99.5988	148.0	7.5
Detroit	1679.0	99.6808	1825.0	99.6530	146.0	8.7

APPENDIX H: CEA MAP



Federal Communications Commission
Wireless Telecommunications Bureau
February 12, 2002

APPENDIX I: POFS PUBLIC SAFETY LICENSEES

LICENSEES (listed by call-sign)

Call Sign	Licensee	City	State
KHQ66	SANTA CLARA, COUNTY OF	PALO ALTO	CA
KMD36	SANTA CLARA, COUNTY OF	SAN JOSE	CA
KRU27	SANTA CLARA, COUNTY OF	MORGAN HILL	CA
WAM273	OKLAHOMA, STATE OF	ADA	OK
WAN212	KANSAS CITY, CITY OF	KANSAS CITY	MO
WAQ637	CALIFORNIA STATE UNIVERSITY CHICO	RED BLUFF	CA
WAQ638	CALIFORNIA STATE UNIVERSITY CHICO	CHICO	CA
WBD362	REGENTS OF THE UNIVERSITY OF CALIFORNIA	LA JOLLA	CA
WBD363	REGENTS OF THE UNIVERSITY OF CALIFORNIA	SAN DIEGO	CA
WBH636	PHILADELPHIA, CITY OF	PHILADELPHIA	PA
WBM576	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	NEW YORK	NY
WBM577	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	FORT LEE	NJ
WBM578	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	FORT LEE	NJ
WBM579	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	NEW YORK	NY
WBV242	ALASKA, STATE OF	FAIRBANKS	AK
WBV266	ALASKA, STATE OF	FAIRBANKS	AK
WCP806	REGENTS OF THE UNIVERSITY OF CALIFORNIA	SAN FRANCISCO	CA
WCP807	REGENTS OF THE UNIVERSITY OF CALIFORNIA	SAN FRANCISCO	CA
WCP808	REGENTS OF THE UNIVERSITY OF CALIFORNIA	SAN FRANCISCO	CA
WCP853	YONKERS, CITY OF	YONKERS	NY
WCP854	YONKERS, CITY OF	YONKERS	NY
WCP855	YONKERS, CITY OF	YONKERS	NY
WCP856	YONKERS, CITY OF	YONKERS	NY
WDQ35	OKLAHOMA, STATE OF	OKLAHOMA CITY	OK
WED535	WISCONSIN, STATE OF	MADISON	WI
WEE352	OKLAHOMA, STATE OF	MIAMI	OK
WEE353	OKLAHOMA, STATE OF	WELCH	OK
WEE355	OKLAHOMA, STATE OF	BARTLESVILLE	OK
WEE422	KENTUCKY, COMMONWEALTH OF	FRANKFORT	KY
WEE546	OKLAHOMA, STATE OF	GEARY	OK
WEE547	OKLAHOMA, STATE OF	EL RENO	OK
WEE548	OKLAHOMA, STATE OF	WEATHERFORD	OK
WEE841	OKLAHOMA, STATE OF	EMET	OK
WEE842	OKLAHOMA, STATE OF	DURANT	OK
WEE843	OKLAHOMA, STATE OF	FITTSTOWN	OK
WEG394	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	UNION CITY	NJ
WEG805	COUNTY OF LARIMER	FORT COLLINS	CO
WEG806	COUNTY OF LARIMER	AULT	CO
WEH337	Detroit, City	DETROIT	MI
WEH808	Detroit, City	DETROIT	MI
WGT37	PHILADELPHIA, CITY OF	PHILADELPHIA	PA

WGY341	KING, COUNTY OF	SEATTLE	WA
WHC763	OKLAHOMA, STATE OF	JET	OK
WHH456	DELAWARE RIVER AND BAY AUTHORITY	NEW CASTLE	DE
WHH457	DELAWARE RIVER AND BAY AUTHORITY	NEW CASTLE	DE
WHH458	DELAWARE RIVER AND BAY AUTHORITY	NEW CASTLE	DE
WHH459	DELAWARE RIVER AND BAY AUTHORITY	NEW CASTLE	DE
WHH460	DELAWARE RIVER AND BAY AUTHORITY	NEW CASTLE	DE
WHH829	PORTLAND, CITY OF	CORBETT	OR
WHH830	PORTLAND, CITY OF	SANDY	OR
WHI239	ATLANTIC CITY HOUSING AUTHORITY	INLET	NJ
WHI241	ATLANTIC CITY HOUSING AUTHORITY	SHORE PARK	NJ
WHI504	COUNTY OF LARIMER	FORT COLLINS	CO
WHJ780	KENTUCKY, COMMONWEALTH OF	FRANKFORT	KY
WIA653	JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE	BALTIMORE	MD
WIA810	CUYAHOGA COMMUNITY COLLEGE	CLEVELAND	OH
WIA812	CUYAHOGA COMMUNITY COLLEGE	PARMA	OH
WIA813	CUYAHOGA COMMUNITY COLLEGE	CLEVELAND	OH
WIA818	CALIFORNIA STATE UNIVERSITY CHICO	CHICO	CA
WIA951	CALIFORNIA STATE UNIVERSITY CHICO	REDDING	CA
WJB70	RHODE ISLAND, STATE OF	LINCOLN	RI
WJC97	RHODE ISLAND, STATE OF	SCITUATE	RI
WNER313	BREVARD, COUNTY OF	TITUSVILLE	FL
WNER314	BREVARD, COUNTY OF	SHARPES	FL
WNES281	BREVARD, COUNTY OF	MELBOURNE	FL
WNES282	BREVARD, COUNTY OF	ROCKLEDGE	FL
WNES283	BREVARD, COUNTY OF	MELBOURNE	FL
WNES690	JACKSON COUNTY SHERIFF	JACKSON	MI
WNES691	JACKSON COUNTY SHERIFF	NAPOLEON	MI
WNES692	JACKSON COUNTY SHERIFF	GRASS LAKE	MI
WNES693	JACKSON COUNTY SHERIFF	BROOKLYN	MI
WNES695	JACKSON COUNTY SHERIFF	JACKSON	MI
WNES696	JACKSON COUNTY SHERIFF	SPRINGPORT	MI
WNTK229	PENNSYLVANIA, COMMONWEALTH OF	HARRISBURG	PA
WOW71	SANTA CLARA, COUNTY OF	SAN JOSE	CA
WOW72	SANTA CLARA, COUNTY OF	SAN JOSE	CA
WOW73	SANTA CLARA, COUNTY OF	SAN JOSE	CA
WPO93	PORT AUTHORITY OF NEW YORK AND NEW JERSEY	NEW YORK	NY
WPP84	OKLAHOMA, STATE OF	WILBURTON	OK
WPZ80	HOUSTON, CITY OF	HOUSTON	TX

APPENDIX J: A METHOD TO CALCULATE MVDDS EPFD CONTOURS

Description of Methodology Used To Compute EPFD Contour.

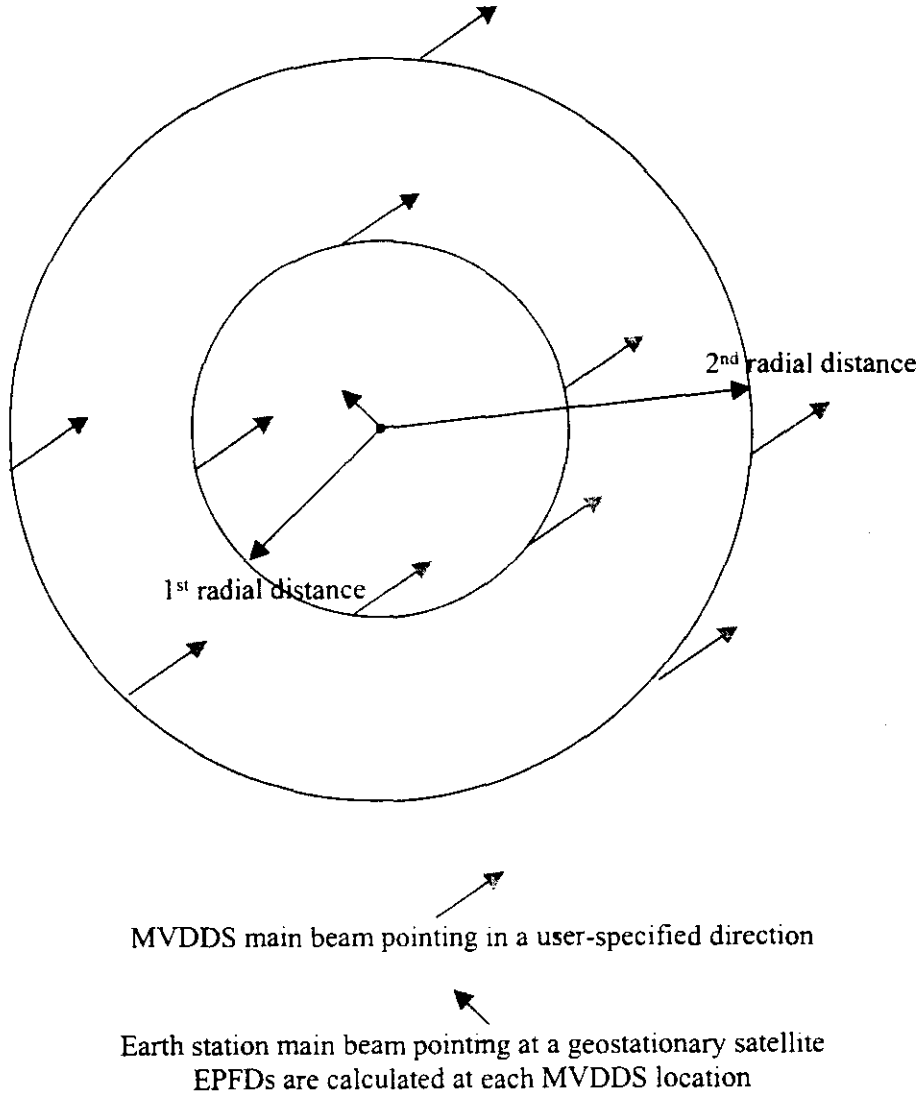
This computer model calculates the area around an MVDDS transmitting antenna where the specified EPFD limit may be exceeded within a DBS subscriber's earth station (DBS receive dish). This generally occurs when the DBS earth station has a direct line of sight to the MVDDS transmitting antenna and its distance and orientation relative to the MVDDS transmitting antenna are such that the MVDDS signal exceeds the specified EPFD limit.

The model calculates the MVDDS EPFD for all azimuths around the MVDDS transmitting antenna and a range of distances between the MVDDS transmitting antenna and the DBS earth station. These calculated EPFDs are then used to draw the contour within which the user specified EPFD level may be exceeded. The contour calculation is for the worst case, which assumes free space propagation loss and no cross polarization isolation. The program allows the user to specify antenna gain patterns for the MVDDS transmit antenna as well as the DBS earth station, so long as the data is in the format shown in Annex I. Mathematical details of the computational methods used are presented in Annex II and sample EPFD contour plots are shown in Annex III. The model was programmed using MATLAB and is available for downloading from the Commission's web site at http://www.fcc.gov/oet/dockets/et98-206/.

General Description of Model Methodology

Figure 1 presents a pictorial description of the general layout of the model. It shows the relative positions and orientations of the MVDDS transmitting antenna and DBS earth station within the model. This figure should be used as a reference throughout the following discussion.

Figure 1: Top View of System Configuration



The DBS earth station is located at a fixed location (user-specified latitude, longitude, and height above mean sea level (AMSL)) and points at a specified geostationary satellite. The MVDDS antenna is located at various positions around the DBS earth station and points in a specified azimuth direction (the user also specifies a tilt angle and AMSL). The algorithm places the MVDDS transmitting antenna a far distance from the DBS earth station and then computes the EPFD at each azimuth, in user-specified degree increments, as it is revolved around the DBS earth station. After EPFDs are computed for all azimuths, the MVDDS transmitting antenna is moved closer to the DBS earth station and the process is repeated. This process repeats until the MVDDS antenna reaches a user-specified distance from the DBS earth station.

Note: For simplicity in the modeling process, our implementation revolves the DBS earth station around the MVDDS transmitter. In practice, the EPFD contour must reflect the situation where a DBS earth station is revolved around the MVDDS transmitting antenna. In both cases, the shape of the EPFD

contour, over the distances of interest, is identical,[687] but the orientations are inverted in the North/South and East/West directions. Therefore, by relabeling the axes of the EPFD contour plot, one obtains the necessary plot.

Model Computations

A. The EPFD is calculated using the following equation:

$$EPFD = \frac{P_{out} * G_m(\theta_m, \phi_m) * G_e(\theta_e, \phi_e) * I}{G_{e,max} * 4\pi * d^2}$$

Where:

P_{out} = Total output power of the MVDDS transmitter (watts) into antenna

$G_m(\theta_m, \phi_m)$ = Gain of the MVDDS antenna in the direction of the DBS earth station

θ_m and ϕ_m are in polar coordinates. θ_m is the angle from the Z axis (θ_m =0°). The main beam of the MVDDS antenna is aligned with the X axis (θ_m =90°, ϕ_m =0°).

$G_e(\theta_e, \phi_e)$ = Gain of the earth station in the direction of the MVDDS antenna

θ_e and ϕ_e follow the same conventions as θ_m and ϕ_m.

I = Interference scaling factor for the earth station.[688] A detailed explanation of this term can be found in Section 3.3.2 of the MITRE Report (http://www.fcc.gov/oet/info/mitrereport/mitrereport_4_01.pdf)

$G_{e,max}$ = Maximum gain of the DBS earth station

d = the distance between the MVDDS transmitting antenna and the DBS earth station (meters)

B. The antenna gain pattern of the MVDDS transmitting antenna and DBS earth station are described in ASCII text files, which are entered as input variables. An example gain input file is shown in Annex I.

C. Azimuth and elevation angles of the DBS earth station and MVDDS transmitting antenna are defined and computed as follows (*see* Figure 2):

[687] This result occurs because the change in elevation angle of the DBS earth station over the distance of an MVDDS service area is negligible. For example, the elevation angle of a DBS earth station in Washington, DC (38.9° north latitude, 77.0° west longitude, 0.01 km AMSL) pointed toward the satellite at 101° west longitude is 38.52 degrees. If that earth station were moved 20 miles east (38.9° north latitude, 76.63° west longitude, 0.01 km AMSL), the elevation angle changes by 0.19 degrees to 38.33 degrees. Because MVDDS service areas will generally be much less than 20 miles across, the difference between the elevation angles of earth stations at the edges of the service area will be even less.

[688] The interference scaling factor is 1 dB for MVDDS transmitters employing the modulation discussed in Section 3.1.5 of the MITRE Report (*i.e.*, a QPSK modulated signal passed through a square-root raised cosine filter). For other modulation and filtering schemes, the interference scaling factor can be measured using the procedures described in Appendix A of the MITRE Report.

1. The user specifies the latitude, longitude, and height AMSL of the DBS earth station. Additionally, the user specifies the longitude of the geostationary satellite to which the earth station should point.

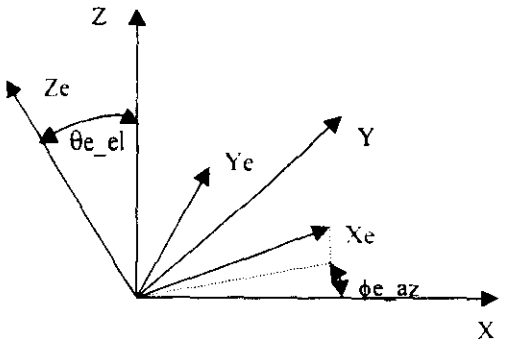
2. The elevation angle of the DBS earth station, θe_el, is the angle from the horizon to the main beam of the DBS earth station.

3. The azimuth angle of the DBS earth station, ϕe_az, is the angle from the projection of geographic south on the horizon to the projection of the main beam on the horizon.

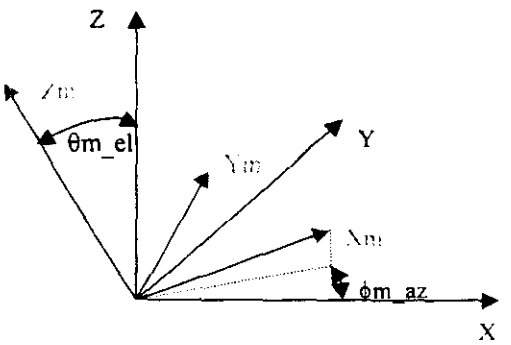
4. The tilt angle (θm_el) and the azimuth (ϕm_az) of the MVDDS antenna are user-specified input variables; defined by the same conventions as θe_el and ϕe_az.

5. The method used to calculate angles θ_e, ϕ_e, θ_m, and ϕ_m for all geometric configurations of the DBS earth station and the MVDDS transmitting antenna is presented in Annex II. (Note: Because calculated θ_e, ϕ_e, θ_m, and ϕ_m may not exactly match the values of these angles present in the input antenna gain files, a linear interpolation is performed to determine the values of $G_e(\theta_e, \phi_e)$ and $G_m(\theta_m, \phi_m)$ used in the EPFD calculation.

Figure 2: Azimuth and Elevation Angles



DBS Earth Station
Main Beam is aligned with Xe axis



MVDDS Transmitter
Main Beam is aligned with Xm axis

D. The EPFD for each of the geometric configurations is calculated and stored in a matrix. Once all EPFDs are calculated, the matrix is searched, along each azimuth radial, beginning at the farthest distance from the DBS earth station. At each distance, the calculated EPFD is compared to the user-specified threshold EPFD.

If the calculated EPFD is less than the threshold EPFD, then the EPFD at the next point closer to the MVDDS transmitting antenna along the same azimuth radial is compared to the threshold EPFD.

If the calculated EPFD is greater or equal to the threshold EPFD, then that MVDDS antenna location is plotted on a polar graph.

If the threshold EPFD is not exceeded at any distance along a given azimuth radial, then a point is plotted at the origin of the polar graph (the location of the DBS earth station)

This process is repeated until all azimuth radials have been checked.

Note: The described algorithm plots the first point it finds that exceeds the EPFD threshold for each azimuth radial and then moves on to the next azimuth radial. It is possible that if the EPFDs along a given azimuth are compared to the threshold at distances closer than this plotted point, the calculated EPFD could become lower than the threshold and then higher again (creating 'holes' within the larger contour where the EPFD limit is not exceeded). These 'holes' are not plotted under the current implementation of our model.

Annex I: Sample Antenna Gain Input File

Antenna gain data is provided over the complete sphere as a function of spherical coordinate angles in arbitrary incremental steps. As shown in Figure 2, the antenna is oriented so that the main beam is aligned with the X axis.

θ is the angle from the z axis in degrees.

ϕ is the angle of the projection onto the XY plane relative to the X axis.

Gain (dBi) is defined for each θ, ϕ, polarization, and frequency.

θ	ϕ	Gain	θ	ϕ	Gain	θ	ϕ	Gain	θ	ϕ	Gain
0	-180	0.79	54	-180	-19.2	108	-180	-25	162	-180	-29.7
1	-180	0.96	55	-180	-24.5	109	-180	-23.2	163	-180	-36.8
2	-180	0.95	56	-180	-27.1	110	-180	-23.5	164	-180	-35.6
3	-180	0.81	57	-180	-24.7	111	-180	-26.5	165	-180	-39.9
4	-180	0.45	58	-180	-32.8	112	-180	-23.9	166	-180	-40.5
5	-180	-0.15	59	-180	-31.3	113	-180	-22.3	167	-180	-29.4
6	-180	-0.38	60	-180	-20.5	114	-180	-22.5	168	-180	-24.6
7	-180	-0.66	61	-180	-19.3	115	-180	-22.7	169	-180	-24.3
8	-180	-1.8	62	-180	-19.6	116	-180	-24.2	170	-180	-31.9
9	-180	-2.72	63	-180	-17.4	117	-180	-29.2	171	-180	-32.3
10	-180	-2.93	64	-180	-20.2	118	-180	-32.8	172	-180	-25.8
11	-180	-3.1	65	-180	-16.2	119	-180	-29.5	173	-180	-26.3
12	-180	-3.93	66	-180	-14	120	-180	-26.7	174	-180	-28.8
13	-180	-5.49	67	-180	-11.7	121	-180	-25.2	175	-180	-32.5
14	-180	-5.91	68	-180	-10.3	122	-180	-24.5	176	-180	-59.6
15	-180	-5.38	69	-180	-12.3	123	-180	-24.8	177	-180	-34.1
16	-180	-6.67	70	-180	-182	124	-180	-25.6	178	-180	-31.4
17	-180	-9.66	71	-180	-24.3	125	-180	-27.2	179	-180	-35
18	-180	-8.43	72	-180	-20.8	126	-180	-33.6	180	-180	-37.5
19	-180	-7.21	73	-180	-14.4	127	-180	-35.6	0	-179	0.79
20	-180	-9.32	74	-180	-20.8	128	-180	-30.6	1	-179	0.96
21	-180	-11.3	75	-180	-21.1	129	-180	-30.7	2	-179	0.95
22	-180	-10.3	76	-180	-20.9	130	-180	-29.5	.	.	
23	-180	-12.2	77	-180	-26.5	131	-180	-28.9	.	.	
24	-180	-13	78	-180	-25.1	132	-180	-30.5	.	.	
25	-180	-11.6	79	-180	-25.2	133	-180	-35	180	180	
26	-180	-12.2	80	-180	-23.7	134	-180	-33.7			
27	-180	-15.5	81	-180	-21	135	-180	-36.8			
28	-180	-12.1	82	-180	-23.6	136	-180	-36.6			
29	-180	-11.1	83	-180	-21.9	137	-180	-33.9			
30	-180	-14.9	84	-180	-22.4	138	-180	-32.1			
31	-180	-16.1	85	-180	-21	139	-180	-32.4			
32	-180	-11.3	86	-180	-22.1	140	-180	-36.8			
33	-180	-13	87	-180	-20.9	141	-180	-46.6			
34	-180	-15.3	88	-180	-22.7	142	-180	-49.7			
35	-180	-12	89	-180	-24.8	143	-180	-34.3			
36	-180	-12.5	90	-180	-22.5	144	-180	-32.8			
37	-180	-15.5	91	-180	-19.9	145	-180	-32.1			
38	-180	-9.89	92	-180	-20.1	146	-180	-32			
39	-180	-9.51	93	-180	-17.4	147	-180	-34.3			
40	-180	-12.1	94	-180	-18.4	148	-180	-39.9			
41	-180	-7.12	95	-180	-16.6	149	-180	-41.5			
42	-180	-4.24	96	-180	-17.3	150	-180	-36.1			
43	-180	-5.76	97	-180	-17.8	151	-180	-35			
44	-180	-12.2	98	-180	-18.3	152	-180	-38			
45	-180	-16	99	-180	-19.8	153	-180	-45.8			
46	-180	-13.8	100	-180	-22	154	-180	-50.6			
47	-180	-19	101	-180	-22	155	-180	-45.1			
48	-180	-16.7	102	-180	-23.2	156	-180	-42.4			
49	-180	-16.7	103	-180	-27.5	157	-180	-44.6			
50	-180	-23.4	104	-180	-24.4	158	-180	-46.7			
51	-180	-18.1	105	-180	-25.6	159	-180	-56.8			
52	-180	-19.5	106	-180	-25.8	160	-180	-49.6			
53	-180	-23.2	107	-180	-24.7	161	-180	-27.1			

Annex II: Method Used to Calculate θ_e, ϕ_e, θ_m, and ϕ_m

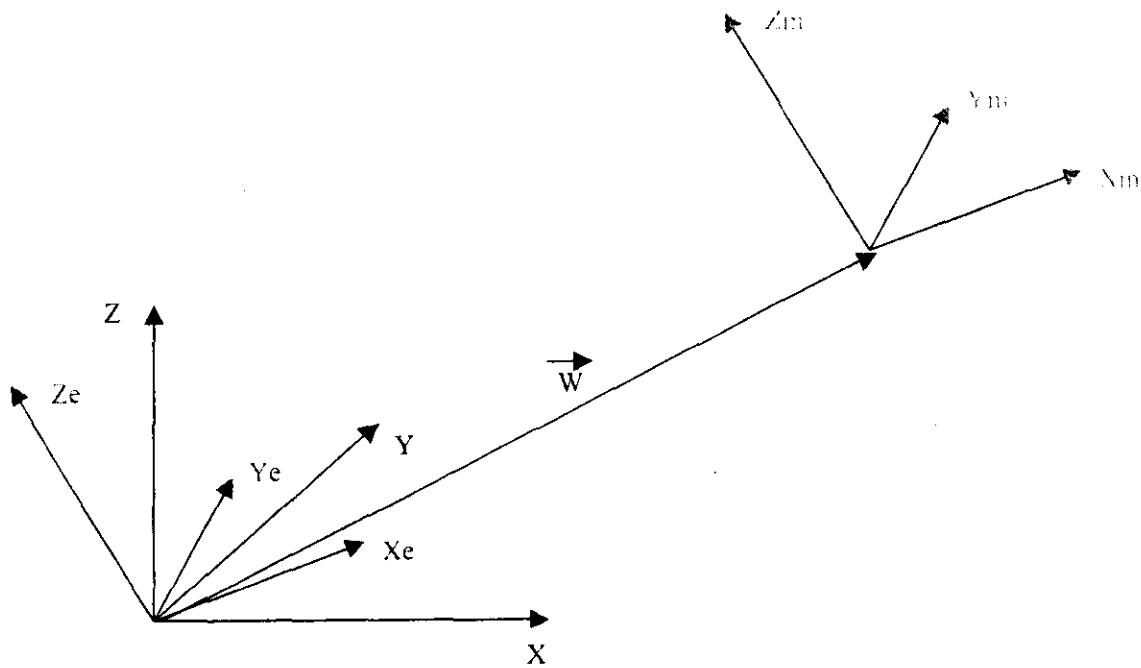
Three coordinate systems are defined and vector analysis is used to determine θ_e, ϕ_e, θ_m, and ϕ_m. These coordinate systems, depicted in Figure 3 are:

1. (X, Y, Z), represents the earth, where X is geographic south and Y is geographic east, and Z is a perpendicular to the surface of the earth.
2. (Xe, Ye, Ze) represents the DBS earth station with its main beam aligned with the Xe axis.
3. (Xm, Ym, Zm) represents the MVDDS transmit antenna with its main beam aligned with the Xm axis.

Note: Coordinate systems (Xe, Ye, Ze) and (Xm, Ym, Zm) are in the same orientation as the antenna gain input files.

The Vector W, is the vector between coordinate systems (Xe, Ye, Ze) and (Xm, Ym, Zm) which connects the two antennas.

Figure 3: Relationship Between the Coordinate Systems



In this Figure, the earth station has an arbitrary azimuth angle (ϕe_az) and an arbitrary elevation angle (θe_el) which are calculated based on its latitude, longitude, height AMSL, and satellite to which it is pointing. The MVDDS antenna also has an arbitrary azimuth angle (ϕm_az) and an arbitrary tilt angle (θm_el), which are user-specified inputs.

(a) Computational Method

To determine θ_e, a dot product operation between W and Ze is performed.

To find ϕ_e, an arctan operation between Wy and Wx is performed.
The same process is used to calculate θ_m, and ϕ_m, except in this case W is negative.

The detailed computational method is presented below.

DBS Antenna:

$$\vec{Xe} = \cos(\theta e_el) * \cos(\phi e_az) * \vec{X} + [\cos(\theta e_el) * \sin(\phi e_az)] * \vec{Y} + \sin(\theta e_el) * \vec{Z}$$

$$\vec{Ye} = -\sin(\phi e_az) * \vec{X} + \cos(\phi e_az) * \vec{Y}$$

$$\vec{Ze} = -[\sin(\theta e_el) * \cos(\phi e_az)] * \vec{X} - [\sin(\theta e_el) * \sin(\phi e_az)] * \vec{Y} + \cos(\theta e_el) * \vec{Z}$$

Solve for X, Y, and Z:

$$\vec{X} = [\cos(\phi e_az) * \cos(\theta e_el)] * \vec{Xe} - \sin(\phi e_az) * \vec{Ye} - [\cos(\phi e_az) * \sin(\theta e_el)] * \vec{Ze}$$

$$\vec{Y} = [\cos(\theta e_el) * \sin(\phi e_az)] * \vec{Xe} + \cos(\phi e_az) * \vec{Ye} - [\sin(\phi e_az) * \sin(\theta e_el)] * \vec{Ze}$$

$$\vec{Z} = \sin(\theta e_el) * \vec{Xe} + \cos(\theta e_el) * \vec{Ze}$$

$$\theta_e = \arccos\left[\frac{\left(\vec{We} \bullet \vec{Ze}\right)}{\left|\vec{We}\right| * \left|\vec{Ze}\right|}\right]$$

$$\phi_e = \arctan\left(\frac{\vec{W}_y}{\vec{W}_x}\right)$$

MVDDS antenna:

$$\vec{Xm} = \cos(\theta m_el) * \cos(\phi m_az) * \vec{X} + [\cos(\theta m_el) * \sin(\phi m_az)] * \vec{Y} + \sin(\theta m_el) * \vec{Z}$$

$$\vec{Ym} = -\sin(\phi m_az) * \vec{X} + \cos(\phi v_az) * \vec{Y}$$

$$\vec{Zm} = -[\sin(\theta m_el) * \cos(\phi m_az)] * \vec{X} - [\sin(\theta m_el) * \sin(\phi m_az)] * \vec{Y} + \cos(\theta m_el) * \vec{Z}$$

Solve for X, Y, and Z:

$$\vec{X} = [\cos(\phi m_az) * \cos(\theta m_el)] * \vec{Xe} - \sin(\phi m_az) * \vec{Ye} - [\cos(\phi m_az) * \sin(\theta m_el)] * \vec{Ze}$$

$$\vec{Y} = [\cos(\theta m_el) * \sin(\phi m_az)] * \vec{Xe} + \cos(\phi m_az) * \vec{Ye} - [\sin(\phi m_az) * \sin(\theta m_el)] * \vec{Ze}$$

$$\vec{Z} = \sin(\theta m_el) * \vec{Xe} + \cos(\theta m_el) * \vec{Ze}$$

$$\theta_m = \arccos\left[\frac{\left(\vec{-W} \bullet \vec{Zm}\right)}{\left|-\vec{W}\right| * \left|\vec{Zm}\right|}\right]$$

$$\phi_m = \arctan\left(\frac{\vec{-W}_y}{\vec{-W}_x}\right)$$

Annex III: Sample EPFD Contour Plots

A sample EPFD contour plot is presented for one city in each of the regions defined in the *Second Report and Order*. These are Washington, DC in the East, Indianapolis, IN in the Midwest, Phoenix, AZ in the Southwest, and Seattle WA in the Northwest. Unless indicated, each of these plots represents the worst-case (or largest zone); the MVDDS transmit antenna and the DBS earth station are at the same height AMSL. In addition, plots for Washington DC show the effect on the size of the EPFD contour of different DBS receive antennas and when the MVDDS transmitting antenna is raised 50 meters above the DBS earth station.

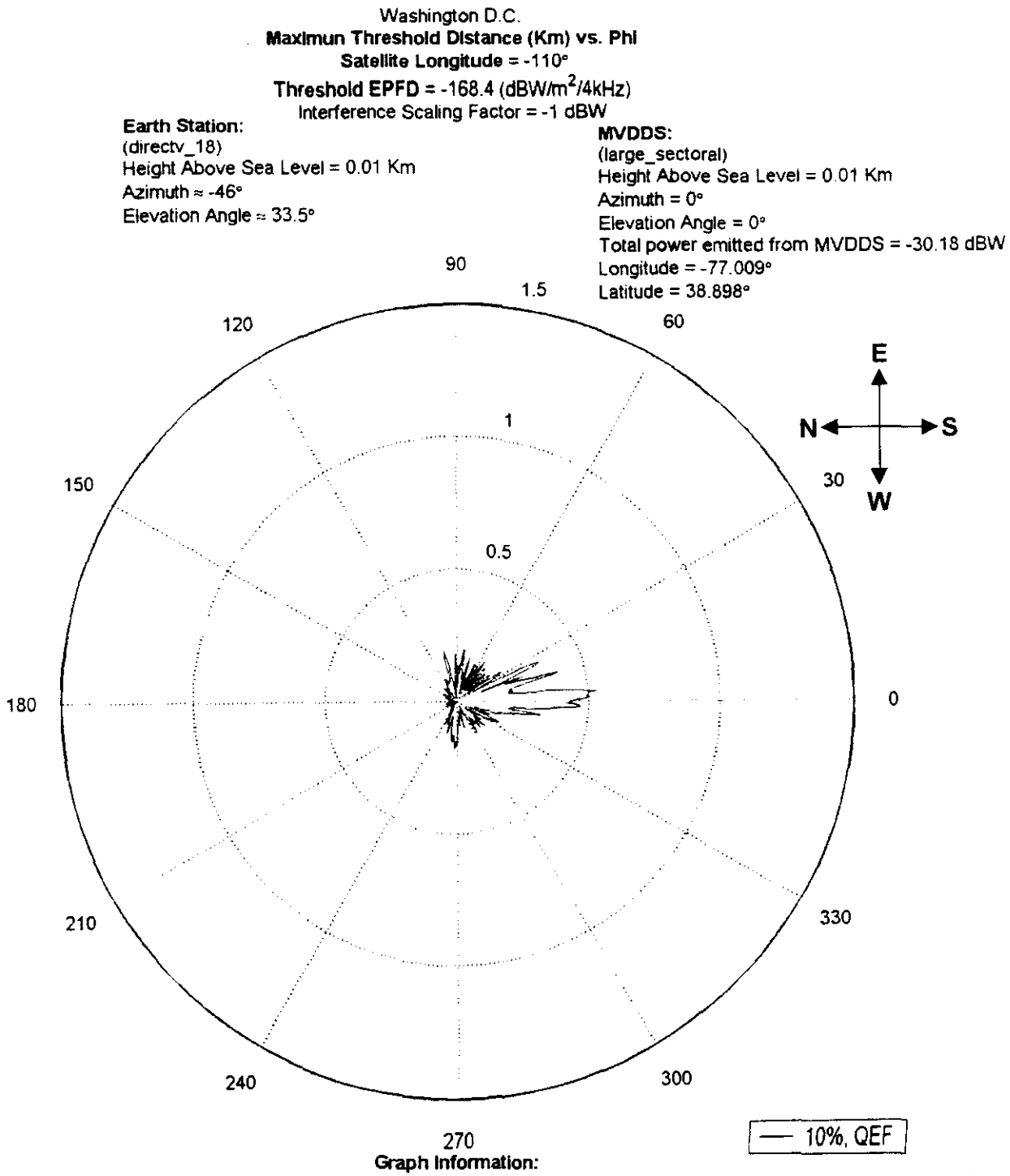
Each plot is drawn under the following conditions:

DBS earth station antenna pattern: 18 inch single feed, 24x18 inch single and dual feed (as indicated on plot)
DBS antenna pattern data is available for downloading at
http://www.fcc.gov/oet/info/mitrereport/
MVDDS transmitting antenna pattern: Northpoint large sector horn (as measured by MITRE)
Antenna pattern data as measured by MITRE is available for downloading at
http://www.fcc.gov/oet/info/mitrereport/

DBS earth station pointing toward the satellite at 110° West Longitude
MVDDS transmitter pointing toward geographic South

In all cases, these plots are drawn by revolving the MVDDS transmitter around a DBS earth station. As explained above, the EPFD contour is inverted prior to plotting.

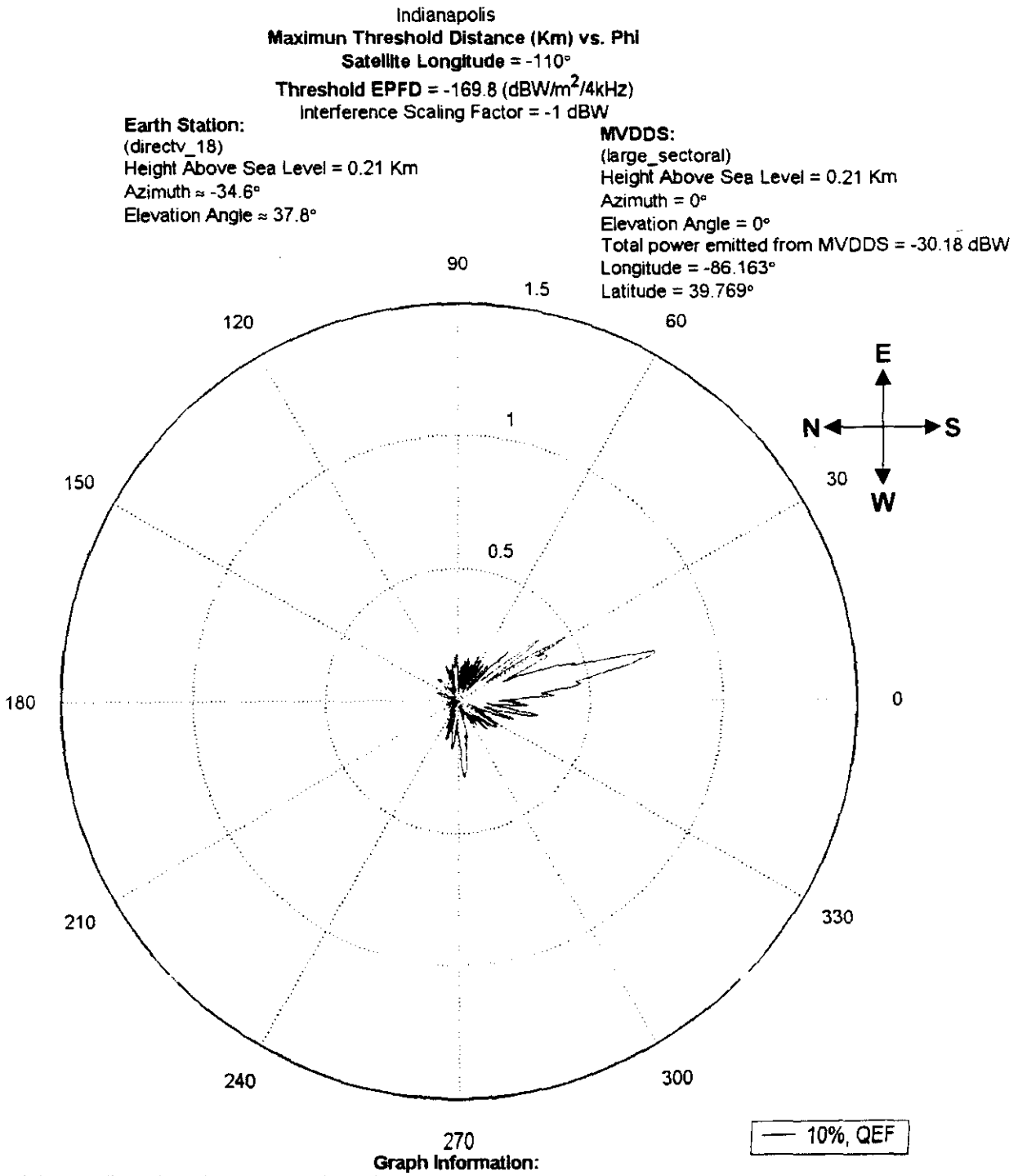
Figure 1: Washington, DC EPFD Contour Using Eastern Region EPFD.
MVDDS Transmit and DBS Receive (18-inch Reflector) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

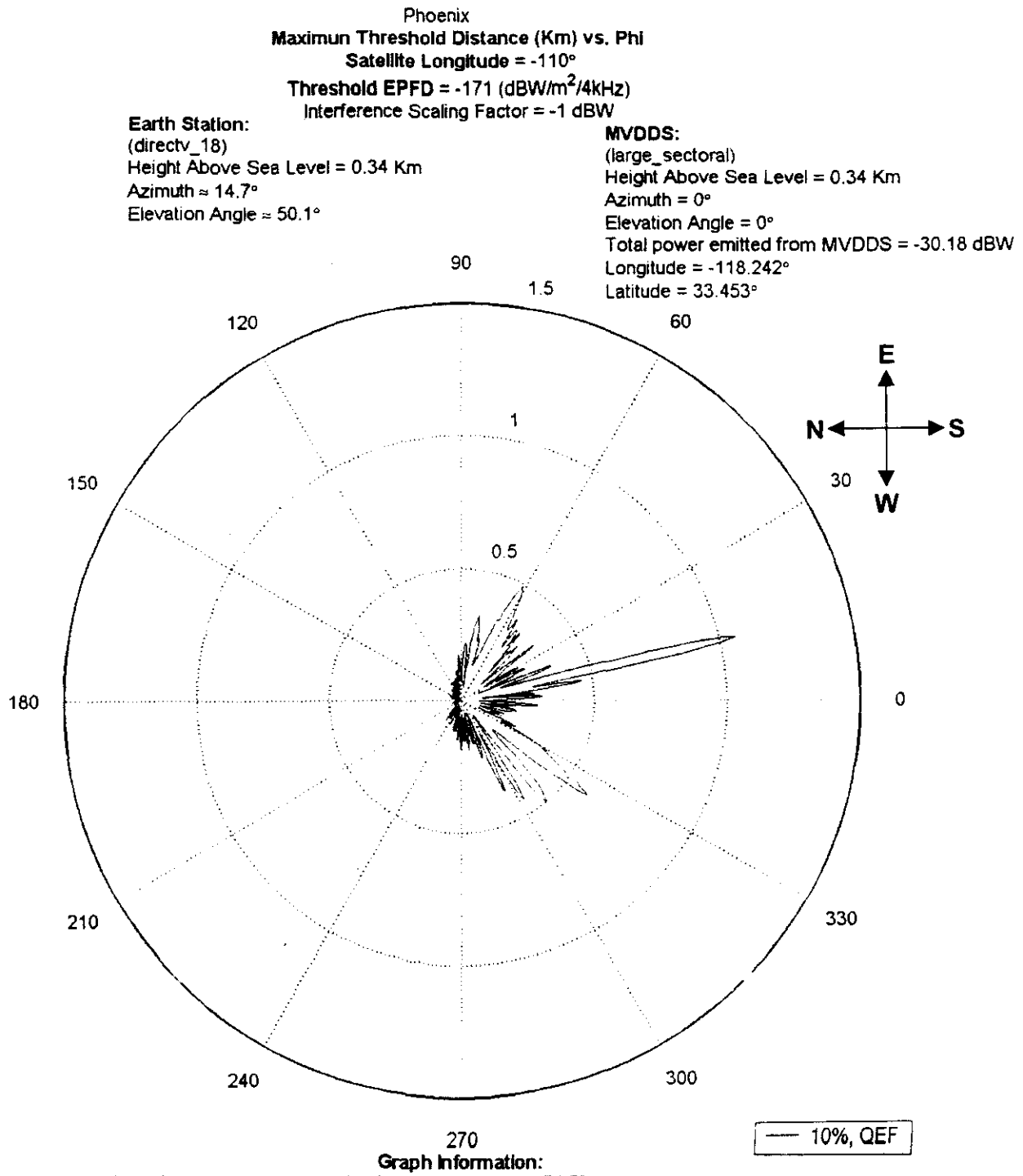
Figure 2: Indianapolis, IN EPFD Using Midwestern Region EPFD.
MVDDS Transmit and DBS Receive (18-inch Reflector) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

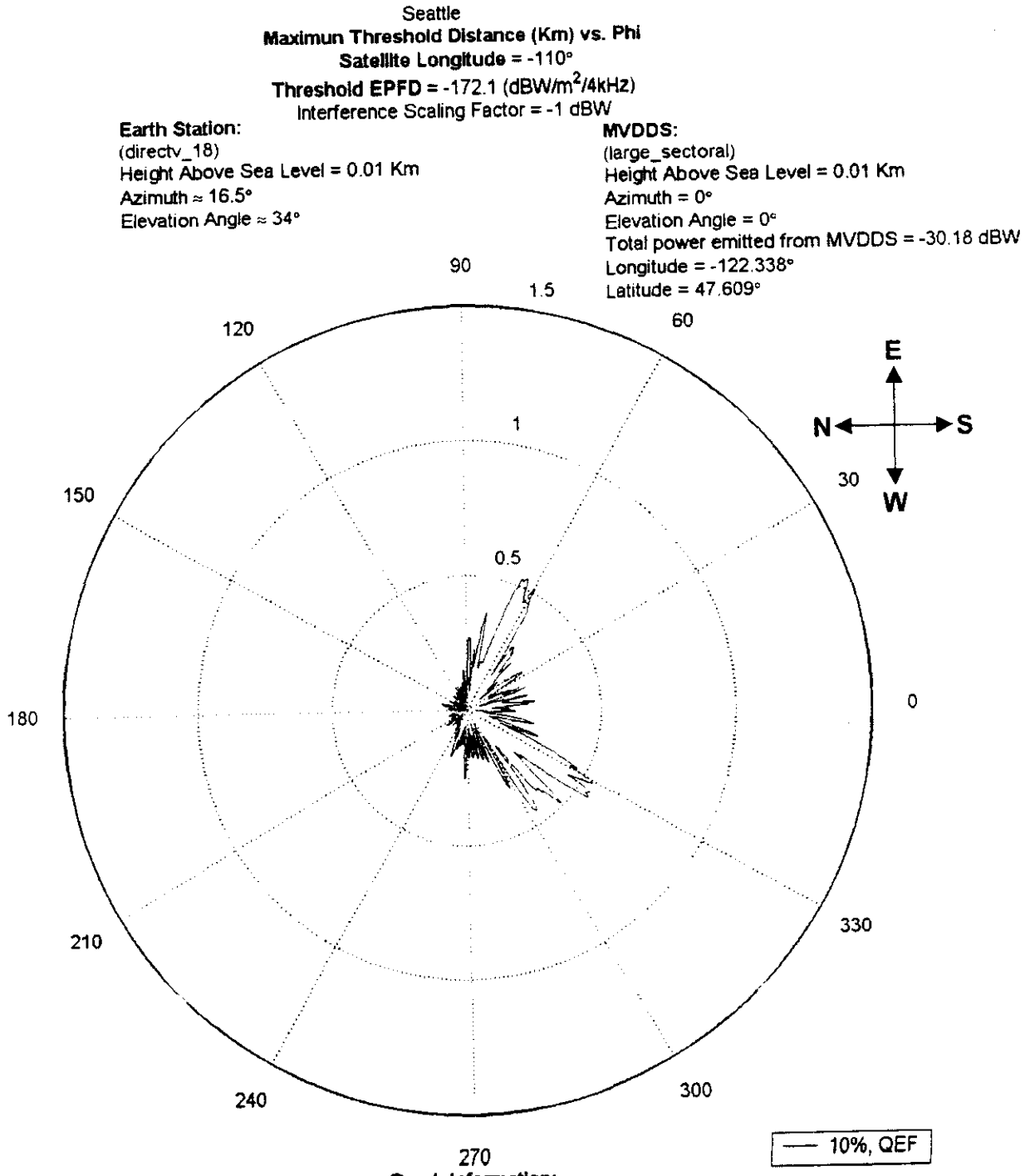
Figure 3: Phoenix, AZ EPFD Contour Using Southwestern EPFD.
MVDDS Transmit and DBS Receive (18-inch Reflector) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

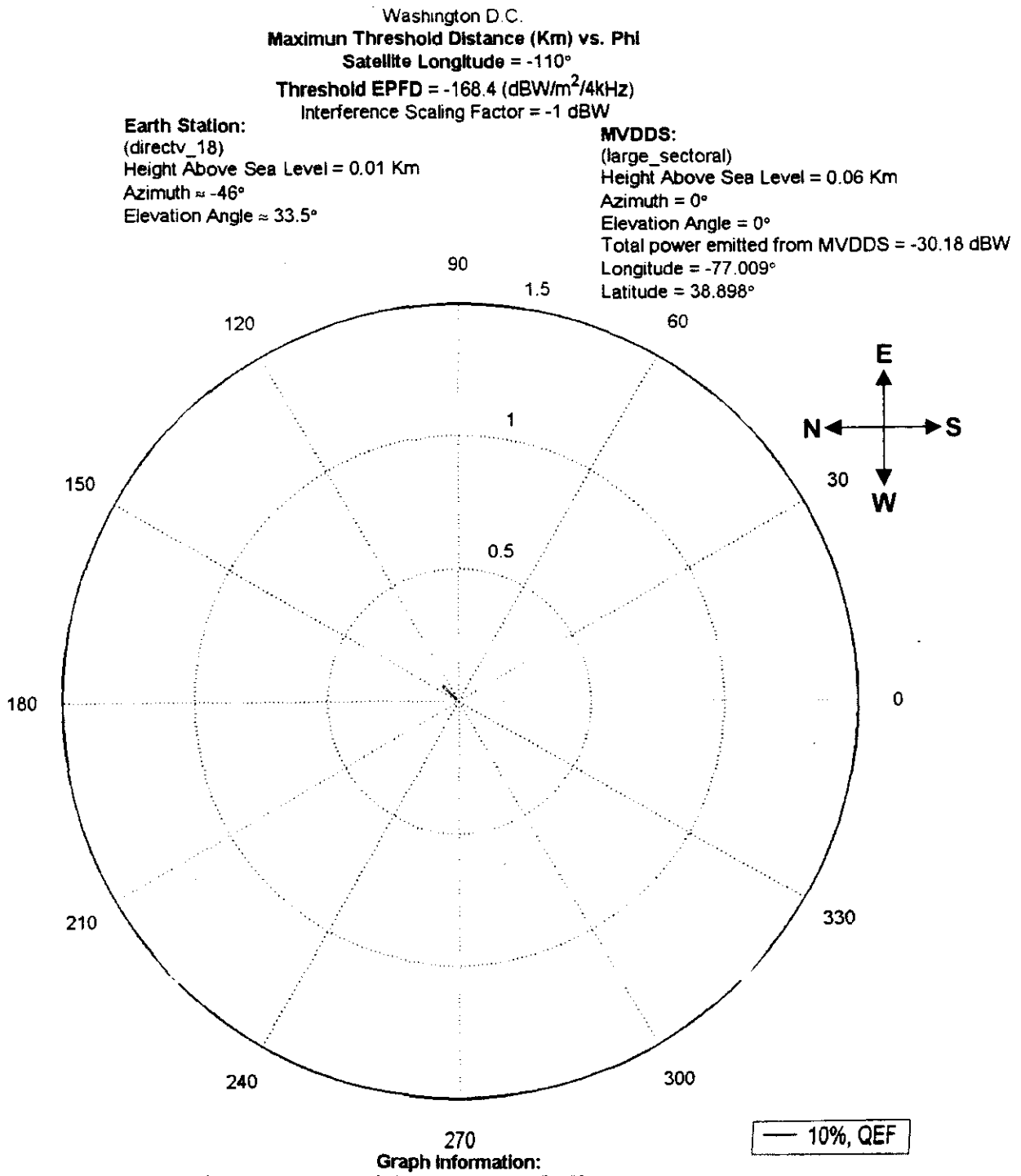
Figure 4: Seattle, WA EPFD Contour Using Northwestern EPFD.
MVDDS Transmit and DBS Receive (18-inch Reflector) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

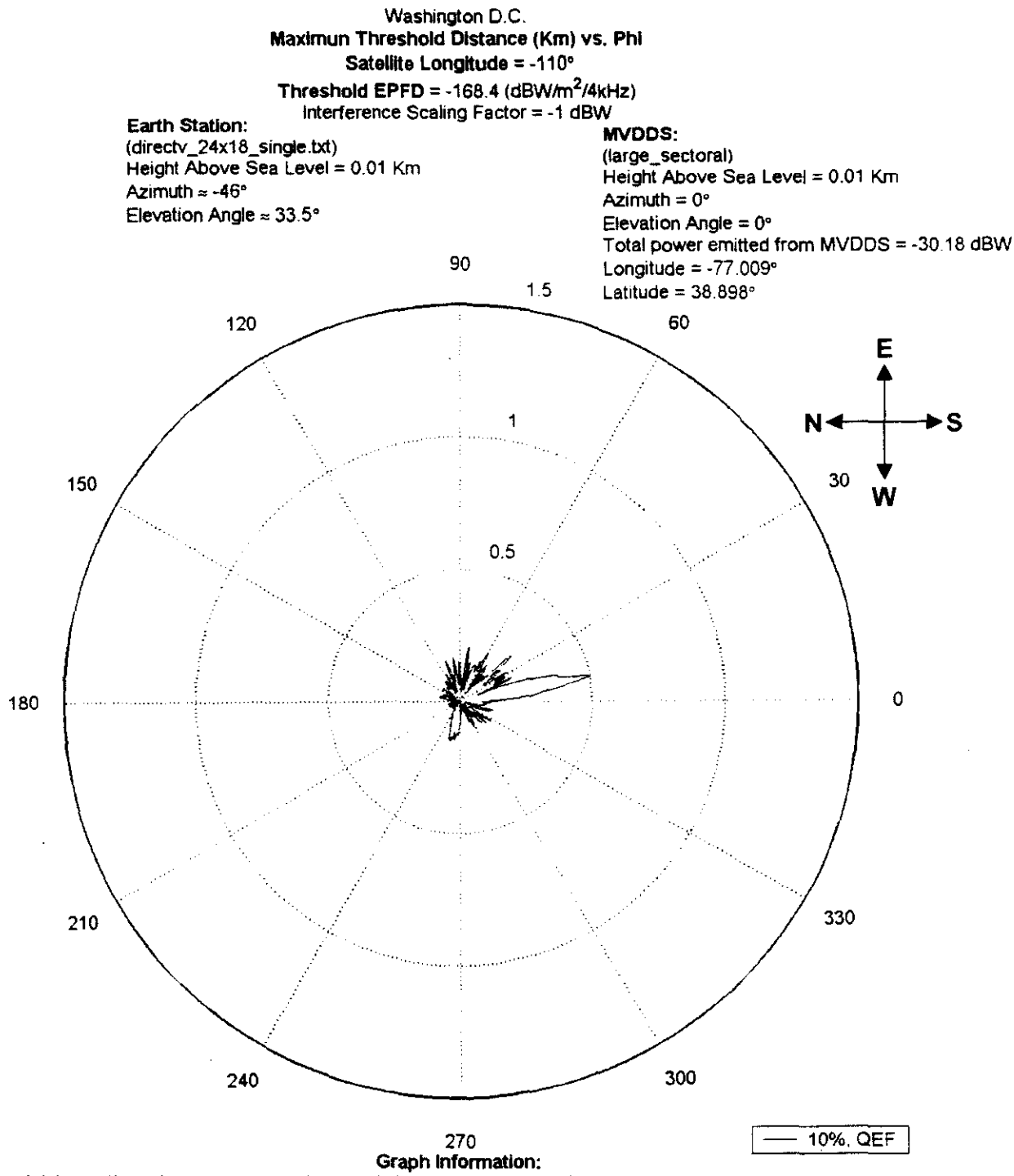
Figure 5: Washington, DC EPFD Contour Using Eastern Region EPFD.
MVDDS Transmit Antenna is 50 Meters higher than DBS Receive (18-inch Reflector) Antenna.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

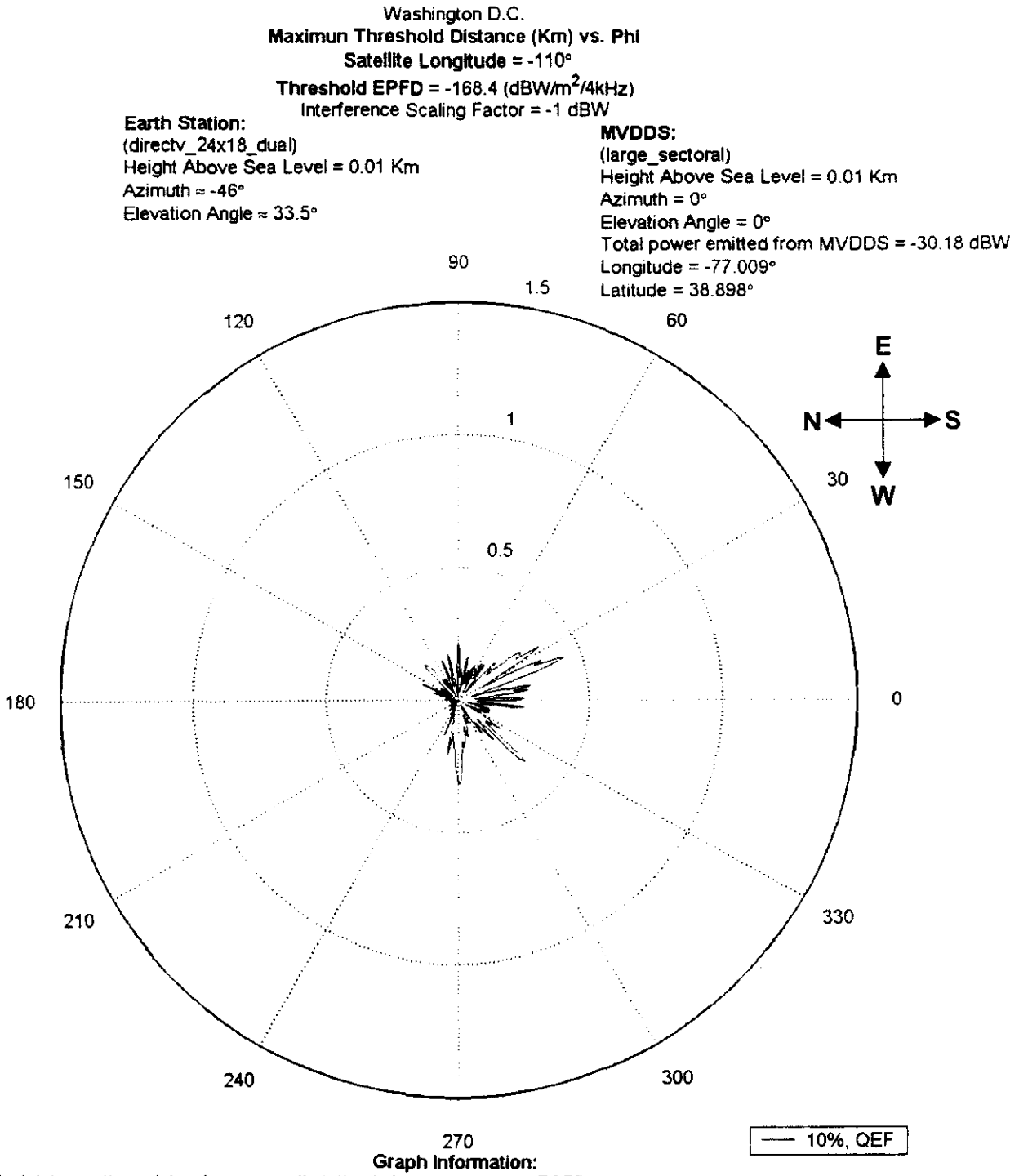
Figure 6: Washington, DC EPFD Contour Using Eastern Region EPFD.
MVDDS Transmit and DBS Receive (24 x 18-inch Reflector With Single Feed) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.

Figure 7: Washington, DC EPFD Contour Using Eastern Region EPFD.
MVDDS Transmit and DBS Receive (24 x 18-inch Reflector With Dual Feed) Antennas Are At Same Height.



Graph Information:

ıtted data are the points where an earthstation is located when the EPFD starts to exceed the specified threshold EPFD.
The MVDDS station is located at the origin.
The coordinate system lays on the surface of the earth. 0° is geographic south. 90° is geographic east.
The EPFD is measured every 0.007 Km.