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1.0 INTRODUCTION

1.1 General

In this Report, an uplink from a Globalstar feederlink station operating in the 5000 MHz to 5250 MHz frequency band is analyzed for its' impact on the microwave landing systems assigned to the 5030 to 5091.7 MHz band.

This report provides background information, the basis for the study, the methodology, the establishment of interference objectives within the 5030 - 5091.7 MHz band, and outside of the LMS band but within the 5000 - 5250 MHz band, the calculation of interference levels, as well as a discussion of interference resolution techniques.

In addition, the interference potential into MLS systems from a specific location that has geographic separation and terrain blockage towards airports/aircraft within a specified coordination area was analyzed and the results were presented in Section 3. While the conclusions are presented in Section 4.

1.2 Background

The MLS system is proposed for the 5030 - 5091.7 MHz band within the United States and the details of this system are available in ARINC Report 727-1. [1] (See Reference Section)

1.3 Basis for Analysis

The analysis presented in this report considers the Globalstar feederlink gateway parameters, the aircraft system parameters, pertinent interference objectives, an estimated coordination distance, and interference reduction techniques. Each of these items will be addressed in the following sections.

1.3.1 Globalstar Feederlink Parameters

The Globalstar feederlink system parameters considered in this study include:

- Maximum Globalstar uplink power density into the antenna is -16.0 dBW/4 kHz.

- The feederlink antenna pattern conforms to 32-25logθ (dBi) envelop towards the horizon. This is the pattern used in the frequency coordination with terrestrial users as stated in the Code of Federal Regulation 47, Part 25, Section 25.251(c)(4). The actual feederlink antenna pattern could be better than the pattern envelop used in this analysis.

- Based on a minimum elevation angle to the low-earth-orbit satellite of 10 degrees, an antenna discrimination angle θ equals 10 degrees minus the elevation angle to the aircraft. The discrimination angle was used to determine the feederlink antenna gain towards the aircraft.

- The maximum power flux density from the earth station towards the horizon is -9 dBW/4kHz (-16 dBW/4kHz + 7 dB).

- The proposed 3.4 meter antenna has a main beam gain of 42.5 dBi at 5.15 GHz.

- The antenna has a beamwidth of 1.3 degrees and 2.6 degrees at the 3 dB and 15 dB points, respectively.

- The satellite arc considered was from 0 to 360 degrees with the minimum elevation angle of 10 degrees in all directions.

1.3.2 Aircraft System Parameters

The analysis in this report is based on the parameters that follow:

- The FCC Master Frequency File of January 1993 listed emission designators at fixed locations in the 5030 - 5091.7 MHz frequency band. These emission designators covered 4 bandwidths 60 kHz, 150 kHz, 300 kHz, and 641 kHz. The 150 kHz and 641 kHz bandwidths will be used in this analysis.

- An aircraft height of 20,000 feet above mean sea level (AMSL) was considered as the maximum height of the aircraft 23 miles from the airports coordinates.

- The coordinates of the airport are from Facility Site Data Airport Facilities Subsystem (MLS) Table [2].

- The received power level at the aircraft was considered to be -95 dBm [1].

1.3.3 Interference Objectives

The interference objective was considered to be -120 dBm [1].

1.3.4 Coordination Distance

A coordination contour distance with a 285 statute mile radius was selected. All airports within this contour were analyzed.

1.3.5 Path Blockage Determination Effort

The path blockage data was based on the following:

- Comsearch used terrain database which is based on digitized 7.5 minute US Geological Survey maps, where Comsearch has not

digitized the 7.5 minute maps, 3 second terrain data from US Gelogical Survey (USGS) digial terrain was used.

- The terrain blockage data is based on a point-to-point analysis. Since, the area from the feederlink to the aircraft is more of a fan beam, one location was selected where several point-to-point profiles were constructed.

- Initially path profiles were constructed from the feeder link location to each airport within the coordination contour then the distance was reduced by 23 miles to obtain a worst case prediction of interference into a landing aircraft.

- The over-the-horizon losses based on terrain blockage used a Path Loss II program from Contract Telecommunication Engineering LTD for the profiles to the airports.

- Comsearch over-the-horizon loss models based on National Bureau of Standards Technical Note 101 Revised (Longly, Rice, et all) was used to estimate the losses to the aircraft locations.

1.3.6 Other Considerations

- Only great circle interference (GC) conflicts were considered in this report.

- The orbital mechanics and the relationship to the amount of time the feederlink antenna main beam is in the direction of the aircraft were not considered.

2.0 Methodology

2.1 Approach

The analyses follow traditional methods of assessing uplink projected interference onto the sharing parties. Given the location of the airports, and a preselected feederlink gateway location, we shall introduce a two layered approach to analyze the resultant interference. The first layer concludes an exclusion zone beyond which no interference is expected. The determination of this exclusion zone is based on calculations involving free space loss, typical geometries, and the required interference objective. The interference objectives are deduced from existing power level interference criteria established in [1]. Additional system parameters, such as transmitter's bandwidth, were obtained from the FCC non-government frequency master list.

The second layer of analysis is concerned with the airports inside the given exclusion zone. For those airports, a search for terrain blockage is conducted. Thereafter, traditional great circle over-horizon-losses are computed. The losses are computed towards several points simulating the location of an airborne platform.The airborne platform is assumed located within a cylindrical volume. The projection of the cylinder's center on the x-y plane, is the airport's location represented by its geodesic coordinates. The cylinder has a radius of 23 statute miles, and a height of 20,000 feet above mean sea level. The cylinder's dimensions are reported in [3], while the airport locations are given in [2]. The great circle over-horizon-loss calculation do not incorporate effects of precipitation scatter, and high-altitude ducting.

Based on the number of frequencies per airport, the resultant limitation on frequencies could be computed.

2.2 Interference assessment into Microwave Landing System (MLS)

Prior to introducing the complete computations in order to assess if interference may result, it is important to know the required levels of protection for the MLS.

2.2.1 Interference Objectives

Based on [1], the interference criteria varies by frequency separation from the interfering signal and the type of interfering signal. The frequencies utilized by an MLS receiver fall within 5030.0 MHz and 5091.7 MHz. Should there be any frequency overlap between the feederlink gateway's signal and the MLS received signal, we infer from [1,set.3.1.5,pp8] that a -120 dBm (or -150 dBW) of interference level should not be exceeded. This level is derived from being 25 dB lower than a minimum required MLS signal amplitude of -95 dBm, or -120 dBm.

Should there not be any signal overlap, then the -120 dBm

requirement could be relaxed. Outside the band 5030.0 MHz and 5091.7 MHz, and assuming no signal overlap, [1,set.1.6(i)] states that an interfering CW signal's amplitude cannot exceed -55 dBm(-85 dBW). To apply this objective, we need to take into account the feederlink's spread spectrum signal's bandwidth, power spectral density, and the filters' selectivity of the MLS receiver. Since the MLS filters' selectivity are not available, an exact objective can't be established, and we shall only assume that the objective is substantially less than the signal overlap criteria.

2.2.2 Predicted Feederlink Power Levels at Airborne Receivers

The predicted power levels given herein are computed at the output of the airborne antenna. The predicted power levels could equivalently be presented at the input to the airborne receiver (or processor) by subtracting an additional 11 dB for fixed losses.

The predicted power levels at the output of the airborne antenna are given by the following equation (see also Figure 2.2.2-1):

$$I_A = -16 + 10 \log (B/4) + G_F - (96.6 + 20 \log D_F + 20 \log f) - OH \text{ (dBW)} \quad (1\text{-}1)$$

Where,

I_A is the interference power at the output of the airborne antenna given in dBW

-16 dBW/4 kHz is the power density at the input of the feederlink's antenna

B is the bandwidth of the airborne receiver (or processor) in kHz

G_F is the gain of the feederlink's antenna towards the airborne antenna, and is given by:

$$G_F = 32 - 25 \log \theta \text{ dBi} \quad (1\text{-}2)$$

where θ is the discrimination angle of 10 degrees minus the elevation angle to the aircraft.

D_F is the distance between the feederlink gateway and the airborne platform in statute miles. The airborne platform's altitude is 20,000 feet above mean sea level. D_F is considered equal to the horizon distance to the aircraft in this study.

f is the mid band frequency, 5125 MHz

OH are the terrain attributed losses between the gateway and the airborne platform given in dB

2.2.3 Free Space Exclusion Zone Determination

The first layer of computation requires the determination of the required distance beyond which the predicted power levels are of no consequence at the output of the airborne antenna. Following equation (1-1), we set OH=0 and solve numerically for θ and D_F, given that I_A should not exceed -150 dBW for an airborne platform height of 20,000 feet, and a minimum feederlink antenna elevation angle towards the satellite of 10 degrees. The results are given in Table 2.2.3-1 for two receivers' bandwidths, 641 kHz and 150 kHz. The two bandwidths were concluded from the 1993 FCC non-government frequency master list.

Based on Table 2.2.3-1, the free space exclusion zone is 225 statute miles for a 150 MHz receiver bandwidth. The distance to the airport is 248 statute miles. Therefore, airports which lie 248 statute miles or greater from the feederlink gateway will not have to be considered for receivers' bandwidths of 150 kHz or less. This distance of 225 statute miles is employed to quickly exclude a large number of airports from the analysis. Table 2.2.3-1 further indicates that with OH of 15 dB, we could locate a feederlink gateway as close as 60 statute miles from an aircraft, or 83 statute miles from an airport, assuming a 150 kHz receiver. With a 15 dB OH, these distances become, 100 and 123 statute miles, for a 641 kHz receiver.

Figure 2.2.2-1
Parameters used in the calculation of the discrimination angle

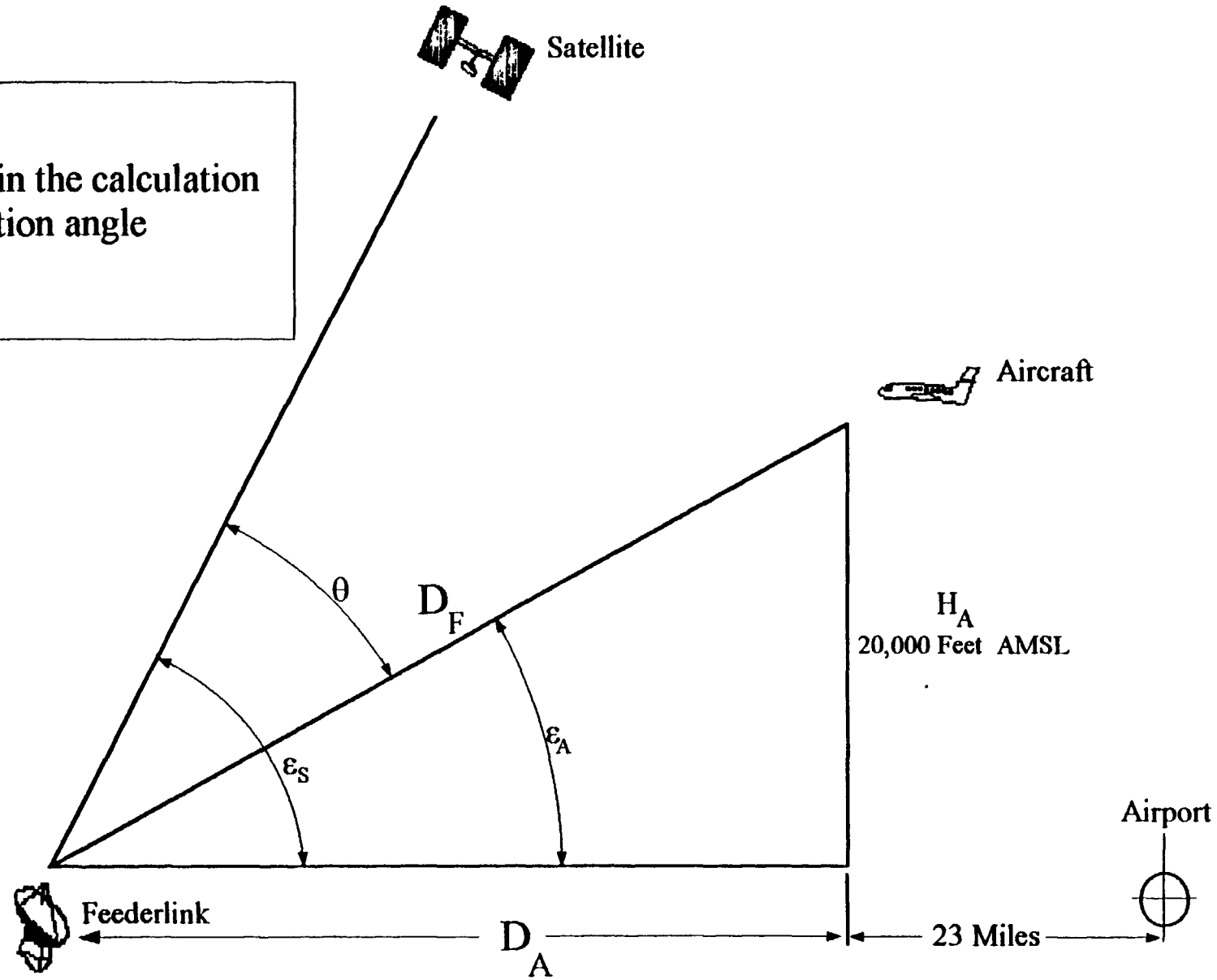


TABLE 2.2.3-1

Determination of Exclusion Zones for Various Airborne Receiver Bandwidths

Distance to Aircraft D_F (miles)	Discrimination Angle Θ (degrees)	Feederlink Antenna Gain, G_F (dBi)	Interference Power, I_A (dBW) BW = 641 kHz	Interference Power, I_A (dBW) BW = 150 kHz	Additional Required OH Losses (dB) BW = 641 kHz	Additional Required OH Losses (dB) BW = 150 kHz
30	2.80	20.8	-113.5	-119.8	36.5	31.2
60	6.39	11.9	-128.5	-134.8	21.5	15.2
100	7.83	9.7	-135.1	141.4	14.9	8.6
140	8.45	8.8	-138.9	145.2	11.1	4.8
180	8.80	8.4	-141.5	-147.8	8.5	2.2
200	8.92	8.2	-142.6	-148.9	7.4	1.1
225	9.03	8.11	-143.7	-150.0	6.3	0

3.0 Approach, Summary of Analysis and Results for Case Study

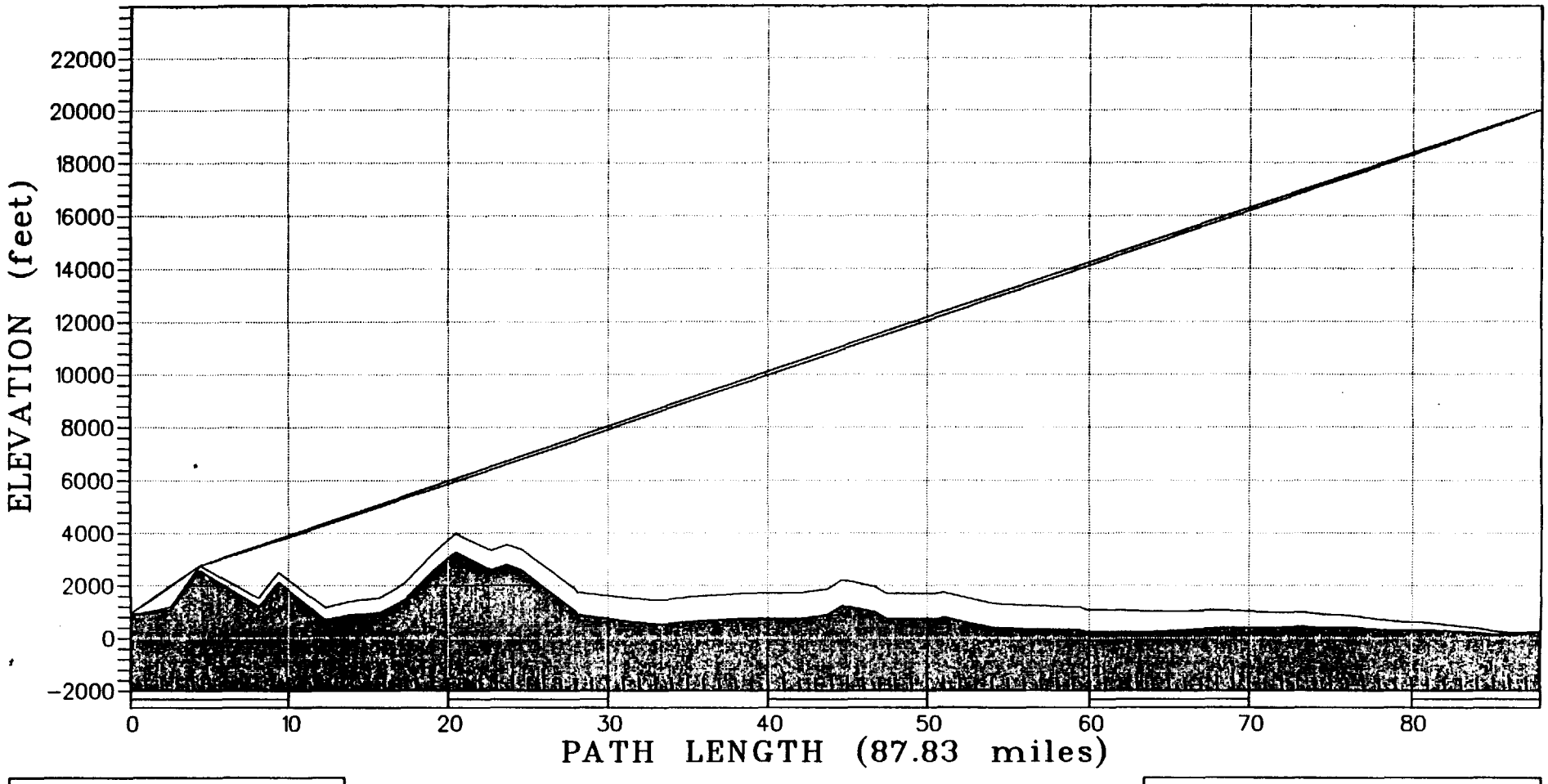
This section of the report analyzes the impact of terrain blockage and man made shielding on reducing the potential interference into an aircraft from a Globalstar feederlink. In this section the parameters of several specific sites are analyzed. The data is then presented for all the analyzed sites. Finally, a summary of results is presented.

3.1 Approach

A site was selected in Williamsville, Virginia to take advantage of near-in terrain shielding. This area is considered a worst case congested area. A total of 75 airports in the states of Virginia, West Virginia, North Carolina, Maryland, Pennsylvania, Delaware, New Jersey and the District of Columbia were analyzed. Sixty five (65) airports were within 248 miles, while ten (10) airports were at distances greater than 248 miles but less than 300 miles from the Williamsville site. Airports that were located more than about 300 miles were excluded from the analysis.

Initially path profiles from the Williamsville site to each of the seventy five airports were constructed. The profiles assumed an aircraft height of 20,000 feet above mean sea level (AMSL) at the airports coordinates. Profiles and associated data for typical sites (ie Williamsville to Washington, DC (DCA), Morgantown, WV (MGW), Pittsburgh, PA (PIT) and to Dublin, VA (PSK)) are presented in Figures 3.1-1 through 3.1-4 and in Tables 3.1-1 through 3.1-4. The profiles are point-to-point and are from the feederlink station to the airport coordinates. Since, the profiles are point-to-point, they do not consider the fan beam area from the feederlink that should be considered in the complete evaluation of each potential interference conflict.

The profile distances were modified to indicate the presence of an aircraft 23 miles from the airport thus, placing the aircraft 23 miles closer to the feederlink station (Figure 3.1-5). As in the earlier profiles the aircraft height was 20,000 feet (AMSL) above this point. Tables 3.1-5 through 3.1-8 present the profile data and the associated over-the-horizon losses for paths from Williamsville, VA to 23 miles from the four typical airports.



WILLIAMSVILL	F 5100.0 MHz	DCA WASHINGT
Lat 038 43 42.0 N	K 1.33	Lat 038 51 07.0 N
Long 078 39 25.0 W	F1 100%	Long 077 02 16.0 W
Bearing 83.922 deg T		Bearing 264.937 deg T
Elev 928 ft AMSL		Elev 250 ft AMSL
Antenna CL 8.0 ft AGL		Antenna CL 19750.0 ft AGL

COMSEARCH

WILLIAMSVILLE – DCA WASHINGTON	Date 05-25-94	By LMS
DIGITIZED TERRAIN DATA	WILL73.PL2	

FIGURE 3.1-1

OHLOSS Report Interference
Diffraction Algorithm Pathloss

	WILLIAMSVILL	DCA WASHINGT		
Latitude	038 43 42.00 N	038 51 07.00 N	Frequency (MHz)	5100.0
Longitude	078 39 25.00 W	077 02 16.00 W	Distance (mi)	87.8
Bearing (deg)	83.922	264.937	Polarization	Vertical
Elevation (ft)	928.0	250.0	K	1.33
Antenna Height	8.0	19750.0	Climate Region	Continental Temperate
Antenna Gain (dBi)				
Effective Antenna Height (ft)	440.2	20190.1	Ground Type	Average
Horizon Distance (mi)	4.4	83.4		
Horizon Elevation (ft)	2582.0	2582.0		
Horizon Angle (deg)	3.994	-2.717		

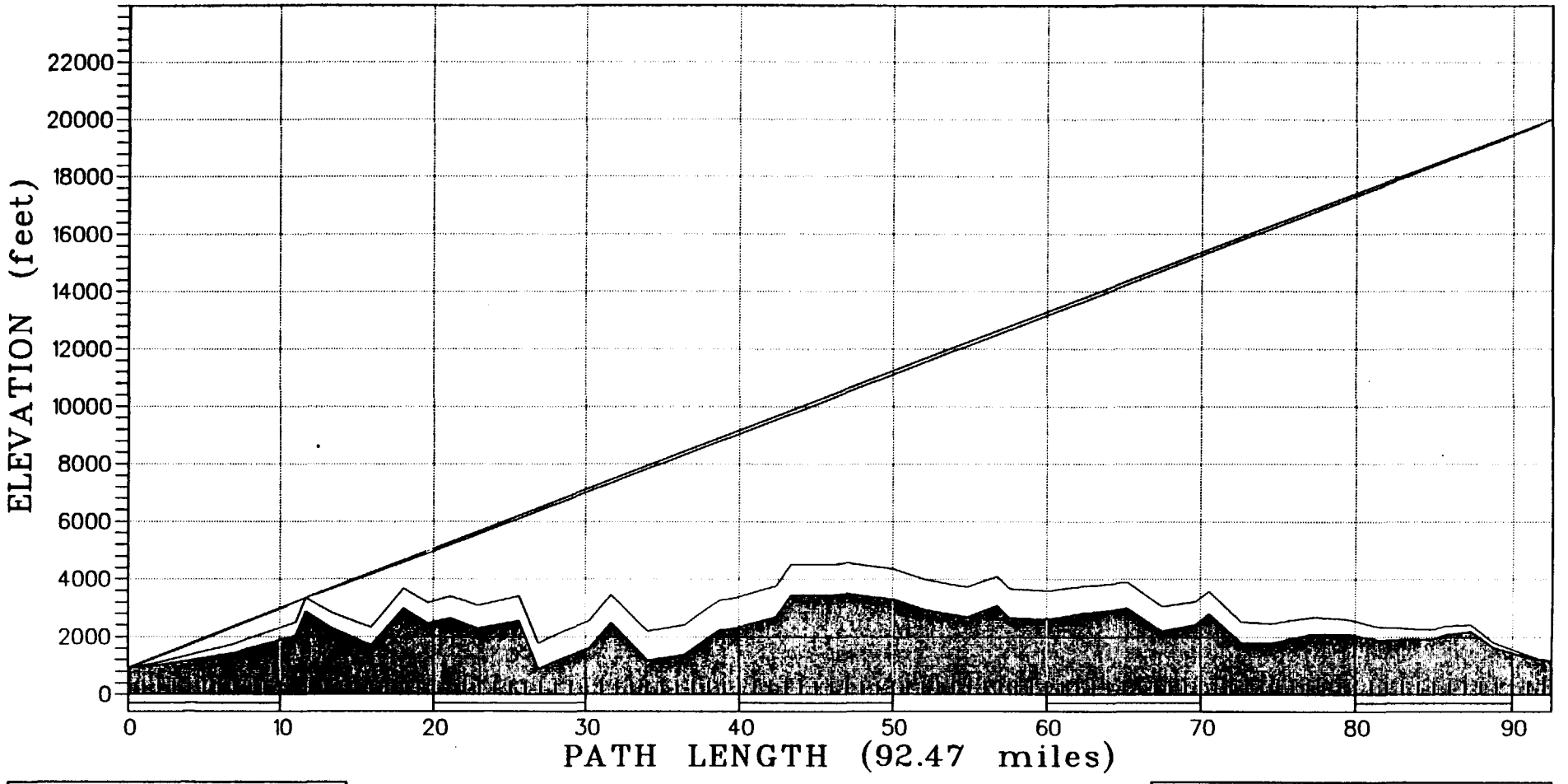
Diffraction Loss (dB)	73.5		
Scatter Loss (dB)	77.4	Combined Loss (dB)	72.0
Median Loss L(0.5) (dB)	71.9		
Free Space Loss (dB)	149.6		
Atmospheric Absorption Loss (dB)	1.1	Total Loss (dB)	222.6

Percent of all hours	Loss Exceeds (P=0.5)	(P=0.95)	
50.0000	71.9 dB	66.0 dB	
80.0000	70.1 dB	64.2 dB	Path is blocked by 1 obstacle(s)
90.0000	69.2 dB	63.1 dB	Path has a common horizon
99.9900	62.9 dB	55.1 dB	
99.9950	62.5 dB	54.6 dB	
99.9975	62.1 dB	54.0 dB	

Ground Elevations - AMSL Structure & Antenna Height - AGL

DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)
0.00	928.0	0.0	0.0	28.12	906.0	0.0	5293.6	59.82	250.0	0.0	12832.9
0.44	900.0	0.0	111.9	31.80	600.0	0.0	6347.0	61.84	250.0	0.0	13304.6
2.52	1069.0	0.0	306.1	33.40	527.0	0.0	6749.2	63.63	250.0	0.0	13727.0
4.44	2582.0	0.0	-867.8	35.80	661.0	0.0	7113.8	65.87	300.0	0.0	14209.7
6.04	1962.0	0.0	37.6	38.62	750.0	0.0	7618.6	68.36	400.0	0.0	14707.7
8.12	1198.0	0.0	1176.5	38.78	750.0	0.0	7653.4	69.90	400.0	0.0	15081.3
9.40	2132.0	0.0	475.3	42.07	750.0	0.0	8354.5	71.51	400.0	0.0	15474.7
12.28	699.0	0.0	2438.2	43.74	900.0	0.0	8564.7	73.35	450.0	0.0	15876.3
13.72	878.0	0.0	2527.2	44.62	1250.0	0.0	8406.6	74.53	400.0	0.0	16218.3
15.64	962.0	0.0	2803.8	46.72	1000.0	0.0	9117.2	76.46	410.0	0.0	16687.5
17.24	1466.0	0.0	2603.1	47.45	750.0	0.0	9527.8	78.61	300.0	0.0	17336.2
19.00	2538.0	0.0	1867.7	50.85	750.0	0.0	10282.7	81.07	300.0	0.0	17959.1
20.44	3282.0	0.0	1401.5	50.95	800.0	0.0	10256.2	83.44	250.0	0.0	18614.9
22.68	2593.0	0.0	2526.6	54.03	400.0	0.0	11351.0	85.01	150.0	0.0	19119.5
23.64	2803.0	0.0	2505.0	56.14	350.0	0.0	11882.8	86.35	150.0	0.0	19464.6
24.60	2594.0	0.0	2903.4	57.87	330.0	0.0	12300.9	87.83	250.0	0.0	0.0
27.96	1035.0	0.0	5132.4	59.43	330.0	0.0	12662.6				

TABLE 3.1-1 PROFILE TO AIRPORT (DCA)



WILLIAMSVILL
Lat 038 43 42.0 N
Long 078 39 25.0 W
Bearing 313.409 deg T
Elev 928 ft AMSL
Antenna CL 8.0 ft AGL

F 5100.0 MHz
K 1.33
F1 100%

MGW MONGANTO
Lat 039 38 34.0 N
Long 079 54 59.0 W
Bearing 132.613 deg T
Elev 1180 ft AMSL
Antenna CL 18820.0 ft AGL

COMSEARCH

WILLIAMSVILLE – MGW MONGANTOWN	Date 06-07-94	By LMS
DIGITIZED TERRAIN DATA	WILL70.PL2	

FIGURE 3.1-2

OHLOSS Report Interference
Diffraction Algorithm Pathloss

	WILLIAMSVILL	MGW MONGANTO		
Latitude	038 43 42.00 N	039 38 34.00 N	Frequency (MHz)	5100.0
Longitude	078 39 25.00 W	079 54 59.00 W	Distance (mi)	92.5
Bearing (deg)	313.409	132.613	Polarization	Vertical
Elevation (ft)	928.0	1180.0	K	1.33
Antenna Height	8.0	18820.0	Climate Region	Continental Temperate
Antenna Gain (dBi)				
Effective Antenna Height (ft)	163.5	18820.0	Ground Type	Average
Horizon Distance (mi)	11.7	80.8		
Horizon Elevation (ft)	2878.0	2878.0		
Horizon Angle (deg)	1.740	-2.736		

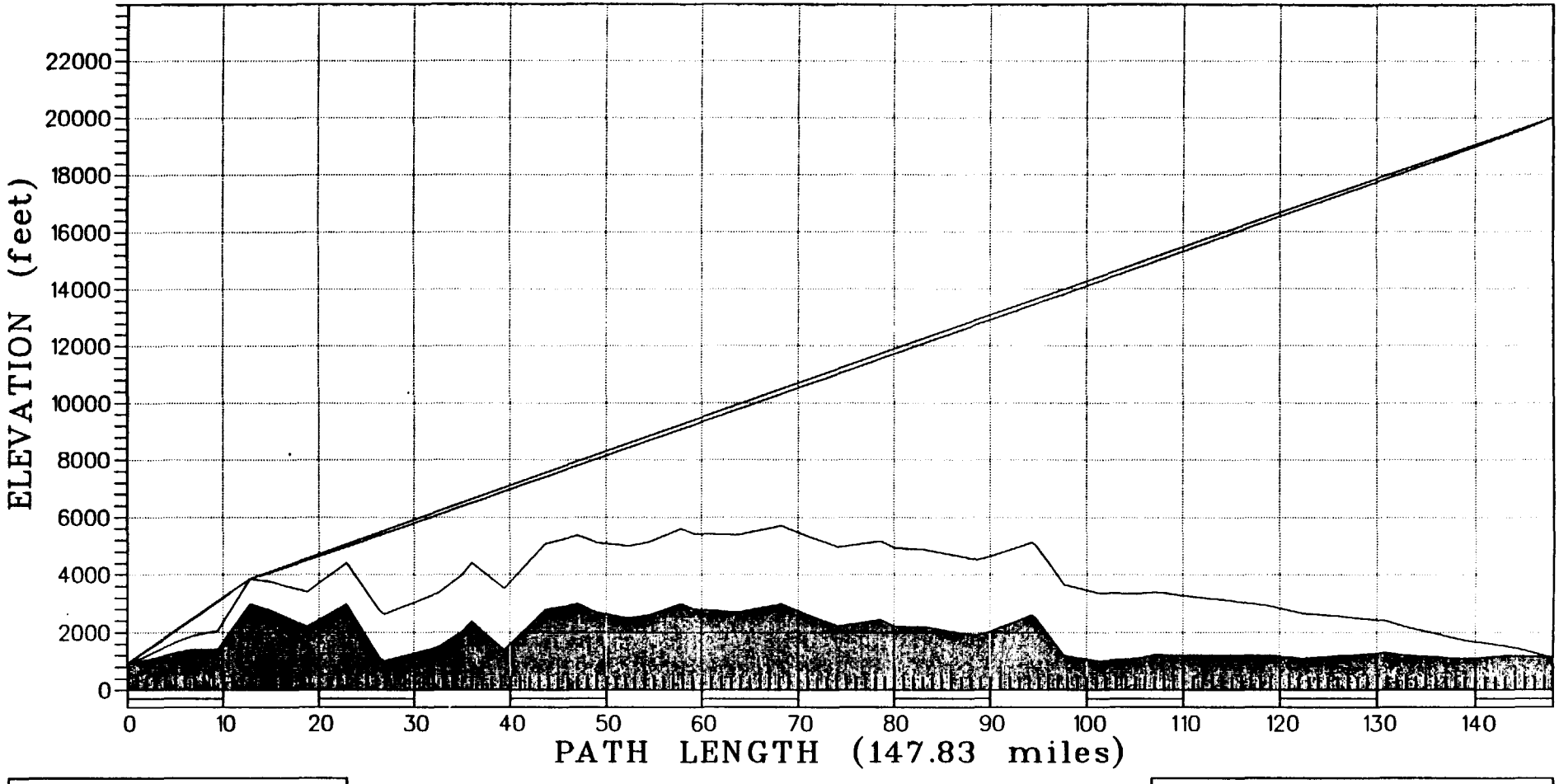
Diffraction Loss (dB)	7.2		
Scatter Loss (dB)	1.9	Combined Loss (dB)	2.4
Median Loss L(0.5) (dB)	2.6		
Free Space Loss (dB)	150.1		
Atmospheric Absorption Loss (dB)	1.2	Total Loss (dB)	148.6

Percent of all hours	Loss Exceeds (P=0.5)	(P=0.95)	
50.0000	2.8 dB	-1.6 dB	Path is LOS for flat earth
80.0000	1.1 dB	-2.9 dB	Path is blocked by 1 obstacle(s)
90.0000	0.3 dB	-3.5 dB	Path has a common horizon
99.9900	-4.0 dB	-5.6 dB	
99.9950	-4.1 dB	-5.7 dB	
99.9975	-4.3 dB	-5.7 dB	

Ground Elevations - AMSL Structure & Antenna Height - AGL

DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)
0.00	928.0	0.0	0.0	31.68	2496.0	0.0	4008.0	65.25	3000.0	0.0	10498.6
1.76	1004.0	0.0	215.0	34.08	1195.0	0.0	5771.8	67.48	2200.0	0.0	11803.7
1.92	1007.0	0.0	237.9	36.48	1383.0	0.0	6052.3	69.65	2420.0	0.0	12079.8
5.12	1287.0	0.0	480.9	38.72	2229.0	0.0	5648.7	70.57	2800.0	0.0	11912.3
7.04	1450.0	0.0	636.6	39.68	2299.0	0.0	5769.9	72.67	1800.0	0.0	13397.9
7.84	1586.0	0.0	634.5	42.40	2700.0	0.0	5915.5	74.67	1800.0	0.0	13865.8
11.04	2051.0	0.0	711.4	43.36	3446.0	0.0	5364.2	77.26	2100.0	0.0	14175.6
11.68	2878.0	0.0	-6.0	46.08	3453.0	0.0	5913.8	78.25	2100.0	0.0	14412.8
13.44	2292.0	0.0	883.6	47.04	3501.0	0.0	6064.1	79.60	2100.0	0.0	14733.6
16.00	1715.0	0.0	1907.7	48.48	3399.0	0.0	6465.1	81.44	1898.0	0.0	15378.5
18.08	2994.0	0.0	996.7	50.08	3298.0	0.0	6900.9	84.96	1933.0	0.0	16199.4
19.68	2451.0	0.0	1825.8	52.16	2938.0	0.0	7699.8	85.76	2095.0	0.0	16233.6
21.12	2650.0	0.0	1886.5	54.88	2689.0	0.0	8529.4	87.36	2198.0	0.0	16525.0
22.88	2296.0	0.0	2560.7	56.80	3087.0	0.0	8545.7	88.80	1647.0	0.0	17433.1
25.60	2554.0	0.0	2803.6	57.60	2661.0	0.0	9145.4	91.68	1198.0	0.0	18602.7
26.88	899.0	0.0	4696.9	60.16	2619.0	0.0	9747.5	92.47	1180.0	0.0	0.0
28.64	1299.0	0.0	4627.2	62.40	2826.0	0.0	10036.1				
30.24	1603.0	0.0	4626.2	63.20	2859.0	0.0	10181.2				

TABLE 3.1-2 PROFILE TO AIRPORT (MGW)



WILLIAMSVILL
Lat 038 43 42.0 N
Long 078 39 25.0 W
Bearing 325.859 deg T
Elev 928 ft AMSL
Antenna CL 8.0 ft AGL

F 5100.0 MHz
K 1.33
F1 100%

PIT PITTSBUR
Lat 040 29 29.0 N
Long 080 13 54.0 W
Bearing 144.855 deg T
Elev 1140 ft AMSL
Antenna CL 18860.0 ft AGL

COMSEARCH

WILLIAMSVILLE – PIT PITTSBURG	Date 06-07-94	By LMS
DIGITIZED TERRAIN DATA	WILL58.PL2	

FIGURE 3.1-3

OHLOSS Report Interference
Diffraction Algorithm Pathloss

	WILLIAMSVILL	PIT PITTSBUR		
Latitude	038 43 42.00 N	040 29 29.00 N	Frequency (MHz)	5100.0
Longitude	078 39 25.00 W	080 13 54.00 W	Distance (mi)	147.8
Bearing (deg)	325.859	144.855	Polarization	Vertical
Elevation (ft)	928.0	1140.0	K	1.33
Antenna Height	8.0	18860.0	Climate Region	Continental Temperate
Antenna Gain (dBi)				
Effective Antenna Height (ft)	135.6	18878.9	Ground Type	Average
Horizon Distance (mi)	12.8	135.0		
Horizon Elevation (ft)	2999.0	2999.0		
Horizon Angle (deg)	1.679	-2.098		

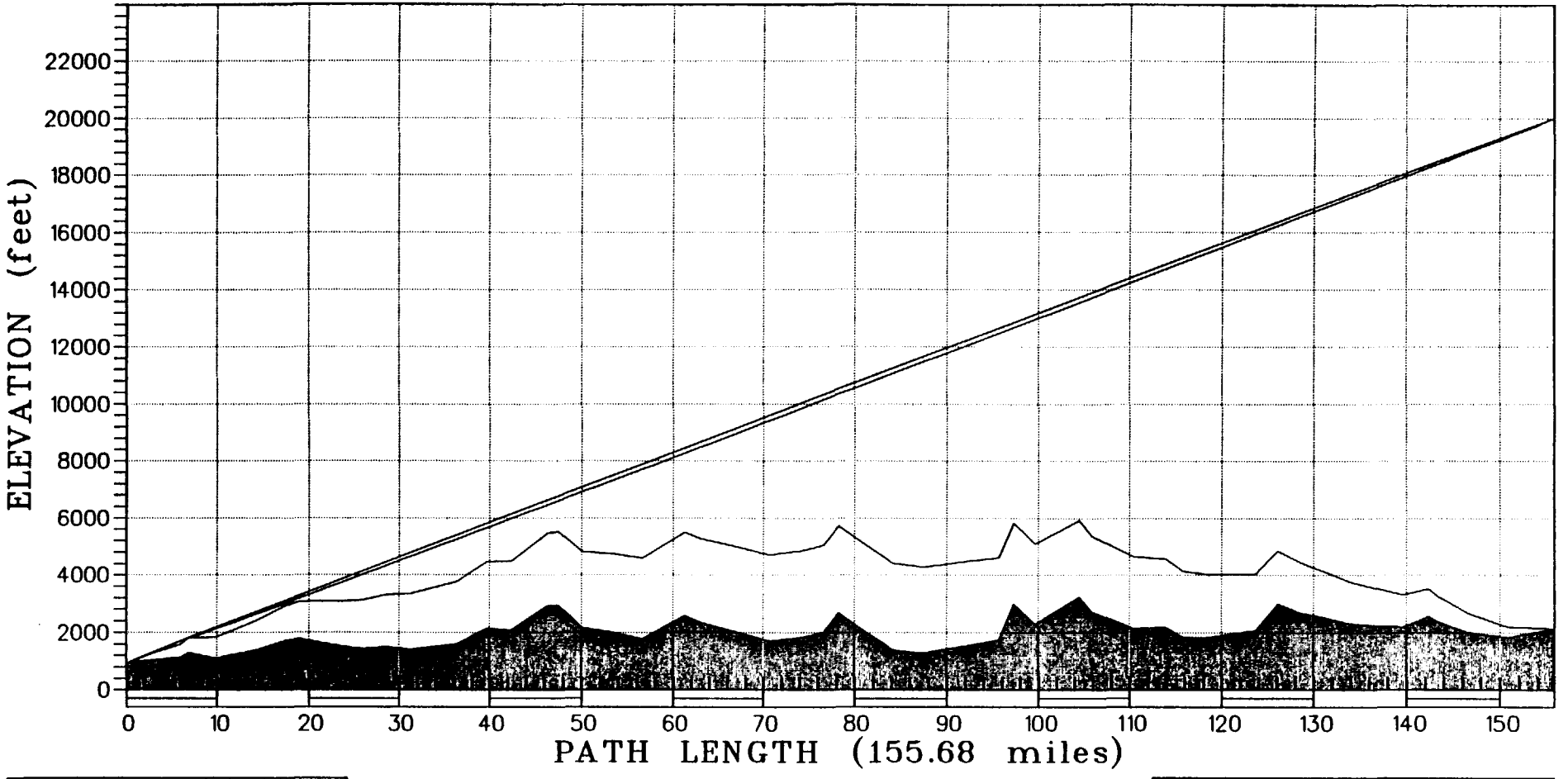
Diffraction Loss (dB)	72.9		
Scatter Loss (dB)	66.7	Combined Loss (dB)	65.7
Median Loss L(0.5) (dB)	65.1		
Free Space Loss (dB)	154.1		
Atmospheric Absorption Loss (dB)	1.9	Total Loss (dB)	221.1

Percent of all hours	Loss Exceeds (P=0.5)	(P=0.95)	
50.0000	65.1 dB	59.3 dB	
80.0000	61.5 dB	55.3 dB	Path is blocked by 1 obstacle(s)
90.0000	59.6 dB	53.0 dB	Path has a common horizon
99.9900	46.8 dB	34.8 dB	
99.9950	46.1 dB	33.8 dB	
99.9975	45.2 dB	32.5 dB	

Ground Elevations - AMSL Structure & Antenna Height - AGL

DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)
0.00	928.0	0.0	0.0	48.96	2694.0	0.0	2135.0	97.67	1200.0	0.0	9880.9
1.44	999.0	0.0	17.3	52.32	2497.0	0.0	2687.1	101.29	1000.0	0.0	10640.5
5.12	1298.0	0.0	-67.1	54.52	2600.0	0.0	2822.3	105.32	1100.0	0.0	11179.7
6.72	1402.0	0.0	-73.6	57.87	3000.0	0.0	2795.5	107.15	1220.0	0.0	11353.6
9.44	1401.0	0.0	99.0	59.17	2800.0	0.0	3143.6	109.72	1200.0	0.0	11794.3
12.80	2999.0	0.0	-1276.7	63.71	2700.0	0.0	3771.6	113.99	1200.0	0.0	12507.5
14.88	2770.0	0.0	-904.4	67.99	2960.0	0.0	4029.1	115.38	1200.0	0.0	12742.4
18.72	2196.0	0.0	-54.6	68.19	3000.0	0.0	4014.0	118.96	1200.0	0.0	13360.4
22.88	2979.0	0.0	-522.1	71.06	2600.0	0.0	4771.9	122.38	1100.0	0.0	14059.9
26.40	1139.0	0.0	1598.3	74.27	2220.0	0.0	5561.6	126.60	1200.0	0.0	14717.4
26.88	997.0	0.0	1779.5	78.55	2440.0	0.0	5904.3	127.29	1200.0	0.0	14843.0
32.48	1486.0	0.0	1764.9	80.16	2200.0	0.0	6360.4	130.89	1300.0	0.0	15406.3
34.88	1992.0	0.0	1471.8	82.95	2200.0	0.0	6742.2	133.07	1200.0	0.0	15914.3
36.00	2385.0	0.0	1180.2	88.65	1900.0	0.0	7844.5	138.74	1100.0	0.0	17097.0
39.36	1395.0	0.0	2481.7	89.74	2000.0	0.0	7901.4	139.24	1100.0	0.0	17193.9
43.68	2796.0	0.0	1497.8	94.31	2600.0	0.0	7973.9	143.01	1200.0	0.0	17833.5
47.04	2988.0	0.0	1643.2	94.66	2500.0	0.0	8126.9	147.83	1140.0	0.0	0.0

TABLE 3.1-3 PROFILE TO AIRPORT (PIT)



WILLIAMSVILL
Lat 038 43 42.0 N
Long 078 39 25.0 W
Bearing 225.809 deg T
Elev 928 ft AMSL
Antenna CL 8.0 ft AGL

F 5100.0 MHz
K 1.33
F1 100%

PSK DUBLIN
Lat 037 08 14.0 N
Long 080 40 43.0 W
Bearing 44.566 deg T
Elev 2105 ft AMSL
Antenna CL 17895.0 ft AGL

COMSEARCH

WILLIAMSVILLE – PSK DUBLIN	Date 06-07-94	By LMS
DIGITIZED TERRAIN DATA	PSKWIL.PL2	

FIGURE 3.1-4

OHLOSS Report Interference
Diffraction Algorithm Pathloss

	WILLIAMSVILL	PSK DUBLIN		
Latitude	038 43 42.00 N	037 08 14.00 N	Frequency (MHz)	5100.0
Longitude	078 39 25.00 W	080 40 43.00 W	Distance (mi)	155.7
Bearing (deg)	225.808	44.566	Polarization	Vertical
Elevation (ft)	928.0	2105.0	K	1.33
Antenna Height	8.0	17895.0	Climate Region	Continental Temperate
Antenna Gain (dBi)				
Effective Antenna Height (ft)	8.0	135.2	Ground Type	Average
Horizon Distance (mi)	6.9	148.8		
Horizon Elevation (ft)	1299.0	1299.0		
Horizon Angle (deg)	0.535	-2.170		

Diffraction Loss (dB)	12.8		
Scatter Loss (dB)	24.4	Combined Loss (dB)	12.5
Median Loss L(0.5) (dB)	9.5		
Free Space Loss (dB)	154.6		
Atmospheric Absorption Loss (dB)	1.9	Total Loss (dB)	166.0

Percent of all hours	Loss Exceeds (P=0.5)	(P=0.95)	
50.0000	9.6 dB	4.1 dB	Path is LOS for flat earth
80.0000	5.2 dB	-0.3 dB	Path is blocked by 1 obstacle(s)
90.0000	3.0 dB	-2.3 dB	Path has a common horizon
99.9900	-5.4 dB	-6.0 dB	
99.9950	-5.5 dB	-6.0 dB	
99.9975	-5.6 dB	-6.0 dB	

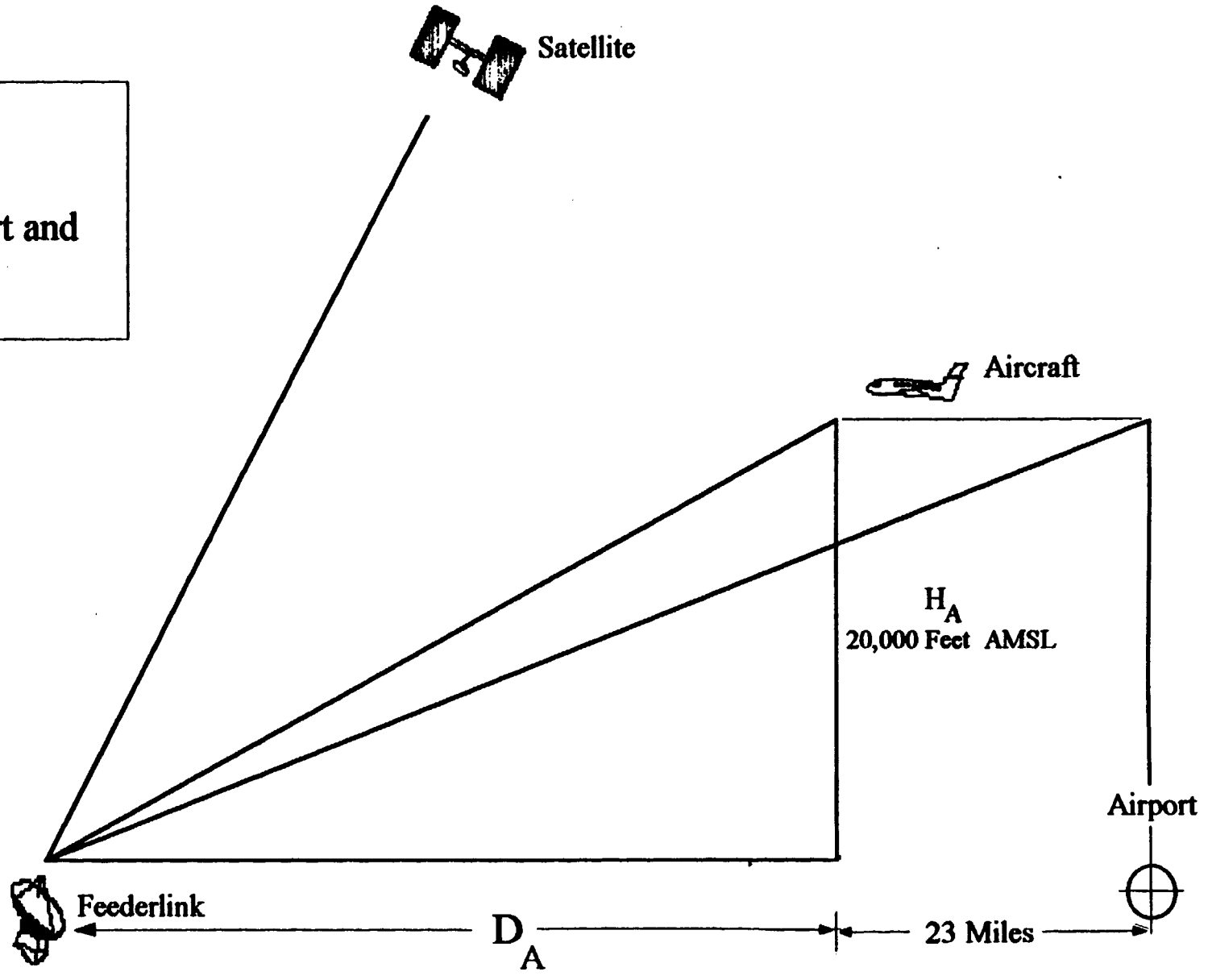
Ground Elevations - AMSL Structure & Antenna Height - AGL

DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)	DIST(mi)	GND(ft)	OBST(ft)	CLR(ft)
0.00	928.0	0.0	0.0	53.44	2001.0	0.0	2746.6	110.40	2149.0	0.0	9806.2
1.60	1000.0	0.0	8.6	56.64	1784.0	0.0	3282.5	113.92	2190.0	0.0	10317.1
6.08	1139.0	0.0	86.6	61.28	2597.0	0.0	2950.1	115.84	1824.0	0.0	10989.4
6.88	1299.0	0.0	-32.5	63.04	2344.0	0.0	3391.0	118.56	1827.0	0.0	11426.5
9.92	1099.0	0.0	328.6	65.92	2110.0	0.0	3939.2	123.68	2066.0	0.0	12036.2
14.40	1398.0	0.0	283.9	70.72	1699.0	0.0	4892.3	126.08	2991.0	0.0	11518.0
17.60	1727.0	0.0	148.8	74.24	1827.0	0.0	5176.4	128.48	2706.0	0.0	12215.6
19.04	1771.0	0.0	195.5	76.64	2012.0	0.0	5279.6	132.00	2465.0	0.0	13072.1
24.00	1499.0	0.0	795.4	78.24	2678.0	0.0	4808.9	133.92	2303.0	0.0	13575.1
25.92	1433.0	0.0	995.0	81.28	2005.0	0.0	5860.0	139.68	2197.0	0.0	14726.2
28.48	1495.0	0.0	1116.8	84.16	1398.0	0.0	6833.7	142.40	2572.0	0.0	14856.2
31.20	1401.0	0.0	1413.3	87.36	1286.0	0.0	7362.9	143.36	2390.0	0.0	15218.2
36.32	1600.0	0.0	1615.5	92.16	1545.0	0.0	7749.0	146.56	2019.0	0.0	16195.9
39.68	2153.0	0.0	1340.1	95.68	1735.0	0.0	8046.6	150.88	1830.0	0.0	17220.2
42.40	2086.0	0.0	1640.1	97.28	2988.0	0.0	7019.4	154.88	2099.0	0.0	17741.3
46.40	2936.0	0.0	1146.1	99.68	2297.0	0.0	8053.8	155.68	2105.0	0.0	0.0
47.52	2943.0	0.0	1241.7	104.48	3235.0	0.0	7820.0				
50.08	2164.0	0.0	2259.8	105.92	2726.0	0.0	8544.8				

TABLE 3.1-4 PROFILE TO AIRPORT (PSK)

Figure 3.1-5

Profiles to airport and aircraft locations



PATHLOSS CALCULATION

WILLIAMSVILLDCA WASHINGT 38 43 42 78 39 25 38 51 7 77 2 16

(5100.00 MHZ)

	SITE 1		SITE 2	
ANTENNA CENTER AGL.....	8.00 FT	2.44 M	0.00 FT	0.00 M
SITE ELEVATION AMSL.....	928.00 FT	282.85 M	20000.00 FT	6096.00 M
ANTENNA CENTER AMSL.....	936.00 FT	285.29 M	20000.00 FT	6096.00 M
EFFECTIVE ANTENNA HT....	8.00 FT	2.44 M	18834.08 FT	5740.63 M
HORIZON DISTANCE.....	4.44 MI	7.14 KM	59.19 MI	95.26 KM
HORIZON ELEVATION AMSL..	2582.00 FT	786.99 M	2582.00 FT	786.99 M
HORIZON ANGLE.....	4.00 DG	69.83 MR	-3.51 DG	-61.34 MR
RAY CROSSOVER ANGLE.....	1.18 DG	20.54 MR		
TERRAIN DELTA HT.....	1521.49 FT	463.75 M		
PATHLENGTH.....	63.63 MI	102.40 KM		
FREQUENCY.....	5100.00 MHZ			
FREE SPACE PATH LOSS....	146.82 DB			
K FACTOR (INPUT).....	1.33 (K)			
RADIO CLIMATIC ZONE.....	ONE 6 CONTINENTAL TEMPERATE			
TYPE OF PATH.....	KNIFE EDGE DIFFRACTION (SINGLE OBSTACLE)			

LOSSES	L-FSPL	SIGMA	CONTROLLING PROPAGATION MODE		
175.18 DB	28.36 DB	3.61 DB	20.	%	DIFFRACTION
168.71 DB	21.88 DB	3.89 DB	1.	%	DIFFRACTION
166.82 DB	19.99 DB	4.13 DB	.1	%	DIFFRACTION
165.51 DB	18.69 DB	4.31 DB	.01	%	DIFFRACTION
164.04 DB	17.22 DB	4.54 DB	.0025	%	DIFFRACTION
163.50 DB	16.68 DB	4.63 DB	.001	%	DIFFRACTION

DIST (MI)	ELEV (FT)	OBST (FT)	K=INF. CLRNCE (FT)	K=1.33 CLRNCE (FT)	DATA TYPE
0.00	928.	8.	0.	0.	3.0
0.44	900.	0.	167.	153.	3.0
2.52	1069.	0.	621.	544.	3.0
4.44	2582.	0.	-316.	-448.	3.0
6.04	1962.	0.	783.	609.	3.0
8.12	1198.	0.	2170.	1945.	3.0
9.40	2132.	0.	1620.	1365.	3.0
12.28	699.	0.	3916.	3600.	3.0
13.72	878.	0.	4168.	3826.	3.0
15.64	962.	0.	4659.	4284.	3.0
17.24	1466.	0.	4635.	4235.	3.0
19.00	2538.	0.	4090.	3666.	3.0
20.44	3282.	0.	3777.	3336.	3.0
22.68	2593.	0.	5138.	4673.	3.0
23.64	2803.	0.	5215.	4743.	3.0
24.60	2594.	0.	5712.	5232.	3.0
27.96	1035.	0.	8278.	7779.	3.0
28.12	906.	0.	8455.	7955.	3.0
31.80	600.	0.	9863.	9357.	3.0
33.40	527.	0.	10415.	9911.	3.0
35.80	661.	0.	11001.	10502.	3.0
38.62	750.	0.	11757.	11275.	7.5
38.78	750.	0.	11806.	11325.	7.5
42.07	750.	0.	12790.	12337.	7.5
43.73	900.	0.	13140.	12705.	7.5
44.62	1250.	0.	13054.	12630.	7.5
46.72	1000.	0.	13935.	13540.	7.5
47.45	750.	0.	14403.	14020.	7.5
50.85	750.	0.	15421.	15096.	7.5
50.95	800.	0.	15402.	15080.	7.5
54.03	400.	0.	16725.	16466.	7.5
56.14	350.	0.	17407.	17197.	7.5
57.87	330.	0.	17946.	17779.	7.5
59.43	330.	0.	18413.	18288.	7.5
59.82	250.	0.	18609.	18495.	7.5
61.84	250.	0.	19213.	19158.	7.5
63.63	20000.	0.	0.	0.	7.5

TABLE 3.1-5 PROFILE TO AIRCRAFT (DCA)

PATHLOSS CALCULATION

WILLIAMSVILLPIT PITTSBUR 38 43 42 78 39 25 40 29 29 80 13 54

(5100.00 MHZ)

	SITE 1		SITE 2	
ANTENNA CENTER AGL.....	8.00 FT	2.44 M	0.00 FT	0.00 M
SITE ELEVATION AMSL.....	928.00 FT	282.85 M	20000.00 FT	6096.00 M
ANTENNA CENTER AMSL.....	936.00 FT	285.29 M	20000.00 FT	6096.00 M
EFFECTIVE ANTENNA HT....	8.00 FT	2.44 M	17853.02 FT	5441.60 M
HORIZON DISTANCE.....	12.80 MI	20.60 KM	109.58 MI	176.34 KM
HORIZON ELEVATION AMSL..	2999.00 FT	914.10 M	2999.00 FT	914.10 M
HORIZON ANGLE.....	1.68 DG	29.31 MR	-2.28 DG	-39.76 MR
RAY CROSSOVER ANGLE.....	0.73 DG	12.73 MR		
TERRAIN DELTA HT.....	1410.62 FT	429.96 M		
PATHLENGTH.....	122.38 MI	196.94 KM		
FREQUENCY.....	5100.00 MHZ			
FREE SPACE PATH LOSS....	152.51 DB			
K FACTOR (INPUT).....	1.33 (K)			
RADIO CLIMATIC ZONE.....	ONE 6 CONTINENTAL TEMPERATE			
TYPE OF PATH.....	KNIFE EDGE DIFFRACTION (SINGLE OBSTACLE)			

LOSSES	L-FSPL	SIGMA	CONTROLLING PROPAGATION MODE		
181.14 DB	28.63 DB	3.61 DB	20.	%	DIFFRACTION
174.67 DB	22.16 DB	3.89 DB	1.	%	DIFFRACTION
172.78 DB	20.27 DB	4.13 DB	.1	%	DIFFRACTION
171.47 DB	18.97 DB	4.31 DB	.01	%	DIFFRACTION
170.00 DB	17.50 DB	4.54 DB	.0025	%	DIFFRACTION
169.46 DB	16.96 DB	4.63 DB	.001	%	DIFFRACTION

DIST (MI)	ELEV (FT)	OBST (FT)	K=INF. CLRNCE (FT)	K=1.33 CLRNCE (FT)	DATA TYPE
0.00	928.	8.	0.	0.	3.0
1.44	999.	0.	161.	74.	3.0
5.12	1298.	0.	436.	135.	3.0
6.72	1402.	0.	581.	192.	3.0
9.44	1401.	0.	1006.	473.	3.0
12.80	2999.	0.	-69.	-770.	3.0
14.88	2770.	0.	484.	-316.	3.0
18.72	2196.	0.	1656.	686.	3.0
22.88	2979.	0.	1521.	383.	3.0
26.40	1139.	0.	3910.	2643.	3.0
26.88	997.	0.	4126.	2843.	3.0
32.48	1486.	0.	4510.	3050.	3.0
34.88	1992.	0.	4378.	2852.	3.0
36.00	2385.	0.	4159.	2604.	3.0
39.36	1395.	0.	5673.	4039.	3.0
43.68	2796.	0.	4945.	3226.	3.0
47.04	2988.	0.	5276.	3504.	3.0
48.96	2694.	0.	5869.	4072.	3.0
52.32	2497.	0.	6590.	4757.	3.0
54.52	2600.	0.	6829.	4979.	7.5
57.87	3000.	0.	6951.	5085.	7.5
59.18	2800.	0.	7355.	5485.	7.5
63.71	2700.	0.	8161.	6292.	7.5
67.99	2960.	0.	8568.	6719.	7.5
68.19	3000.	0.	8559.	6712.	7.5
71.06	2600.	0.	9406.	7583.	7.5
74.27	2220.	0.	10286.	8500.	7.5
78.55	2440.	0.	10733.	9011.	7.5
80.16	2200.	0.	11223.	9531.	7.5
82.95	2200.	0.	11659.	10024.	7.5
88.65	1900.	0.	12846.	11351.	7.5
89.74	2000.	0.	12916.	11451.	7.5
94.31	2600.	0.	13028.	11704.	7.5
94.66	2500.	0.	13183.	11871.	7.5
97.67	1200.	0.	14951.	13744.	7.5
101.29	1000.	0.	15715.	14647.	7.5
105.32	1100.	0.	16244.	15346.	7.5
107.15	1220.	0.	16408.	15592.	7.5
109.72	1200.	0.	16828.	16134.	7.5
113.99	1200.	0.	17494.	17016.	7.5
115.38	1200.	0.	17710.	17306.	7.5
118.96	1200.	0.	18269.	18066.	7.5
122.38	20000.	0.	0.	0.	7.5

TABLE 3.1-7 PROFILE TO AIRCRAFT (PIT)

PATHLOSS CALCULATION

WILLIAMSVILLMGW MONGANTO 38 43 42 78 39 25 39 38 34 79 54 59

(5100.00 MHZ)

	SITE 1		SITE 2	
ANTENNA CENTER AGL.....	8.00 FT	2.44 M	0.00 FT	0.00 M
SITE ELEVATION AMSL.....	928.00 FT	282.85 M	20000.00 FT	6096.00 M
ANTENNA CENTER AMSL.....	936.00 FT	285.29 M	20000.00 FT	6096.00 M
EFFECTIVE ANTENNA HT....	8.00 FT	2.44 M	17538.63 FT	5345.77 M
ANTENNA ANGLE.....	2.59 DG	45.21 MR	-3.34 DG	-58.37 MR
TERRAIN DELTA HT.....	1311.25 FT	399.67 M		
PATHLENGTH.....	69.65 MI	112.09 KM		
FREQUENCY.....	5100.00 MHZ			
FREE SPACE PATH LOSS....	147.61 DB			
K FACTOR (INPUT).....	1.33 (K)			
RADIO CLIMATIC ZONE.....	ONE 6 CONTINENTAL TEMPERATE			
TYPE OF PATH.....	LINE-OF-SIGHT			

L I N E O F S I G H T

DIST (MI)	ELEV (FT)	OBST (FT)	K=INF. CLRNCE (FT)	K=1.33 CLRNCE (FT)	DATA TYPE
0.00	928.	8.	0.	0.	3.0
1.76	1004.	0.	414.	354.	3.0
1.92	1007.	0.	455.	390.	3.0
5.12	1287.	0.	1050.	885.	3.0
7.04	1450.	0.	1413.	1193.	3.0
7.84	1586.	0.	1496.	1254.	3.0
11.04	2051.	0.	1907.	1583.	3.0
11.68	2878.	0.	1255.	917.	3.0
13.44	2292.	0.	2323.	1945.	3.0
16.00	1715.	0.	3601.	3171.	3.0
18.08	2994.	0.	2891.	2425.	3.0
19.68	2451.	0.	3872.	3380.	3.0
21.12	2650.	0.	4067.	3555.	3.0
22.88	2296.	0.	4903.	4368.	3.0
25.60	2554.	0.	5389.	4825.	3.0
26.88	899.	0.	7395.	6820.	3.0
28.64	1299.	0.	7476.	6889.	3.0
30.24	1603.	0.	7610.	7014.	3.0
31.68	2496.	0.	7111.	6510.	3.0
34.08	1195.	0.	9069.	8463.	3.0
36.48	1383.	0.	9538.	8933.	3.0
38.72	2229.	0.	9305.	8707.	3.0
39.68	2299.	0.	9498.	8904.	3.0
42.40	2700.	0.	9842.	9264.	3.0
43.36	3446.	0.	9359.	8789.	3.0
46.08	3453.	0.	10096.	9553.	3.0
47.04	3501.	0.	10311.	9779.	3.0
48.48	3399.	0.	10807.	10294.	3.0
50.08	3298.	0.	11346.	10856.	3.0
52.16	2938.	0.	12275.	11819.	3.0
54.88	2689.	0.	13269.	12864.	3.0
56.80	3087.	0.	13396.	13031.	3.0
57.60	2661.	0.	14041.	13694.	3.0
60.16	2619.	0.	14784.	14499.	3.0
62.40	2826.	0.	15190.	14964.	3.0
63.20	2859.	0.	15376.	15172.	3.0
65.25	3000.	0.	15795.	15651.	7.5
67.48	2200.	0.	17206.	17133.	7.5
69.65	20000.	0.	0.	0.	7.5

TABLE 3.1-6 PROFILE TO AIRCRAFT (MGW)

PATHLOSS CALCULATION

WILLIAMSVILLPSK DUNLIN 38 43 42 78 39 25 37 8 14 80 40 43

(5100.00 MHZ)

	SITE 1		SITE 2	
ANTENNA CENTER AGL.....	8.00 FT	2.44 M	0.00 FT	0.00 M
SITE ELEVATION AMSL.....	928.00 FT	282.85 M	20000.00 FT	6096.00 M
ANTENNA CENTER AMSL.....	936.00 FT	285.29 M	20000.00 FT	6096.00 M
EFFECTIVE ANTENNA HT....	8.00 FT	2.44 M	17981.48 FT	5480.75 M
ANTENNA ANGLE.....	0.85 DG	14.85 MR	-2.28 DG	-39.83 MR
TERRAIN DELTA HT.....	1358.75 FT	414.15 M		
PATHLENGTH.....	132.00 MI	212.43 KM		
FREQUENCY.....	5100.00 MHZ			
FREE SPACE PATH LOSS....	153.16 DB			
K FACTOR (INPUT).....	1.33 (K)			
RADIO CLIMATIC ZONE.....	ONE 6 CONTINENTAL TEMPERATE			
TYPE OF PATH.....	LINE-OF-SIGHT			

L I N E O F S I G H T

DIST (MI)	ELEV (FT)	OBST (FT)	K=INF. CLRNCE (FT)	K=1.33 CLRNCE (FT)	DATA TYPE	DIST (MI)	ELEV (FT)	OBST (FT)	K=INF. CLRNCE (FT)	K=1.33 CLRNCE (FT)	DATA TYPE
0.00	928.	8.	0.	0.	3.0	65.92	2110.	0.	8346.	6168.	3.0
1.60	1000.	0.	167.	63.	3.0	70.72	1699.	0.	9451.	7284.	3.0
6.08	1139.	0.	675.	292.	3.0	74.24	1827.	0.	9831.	7687.	3.0
6.88	1299.	0.	631.	200.	3.0	76.64	2012.	0.	9993.	7871.	3.0
9.92	1099.	0.	1270.	664.	3.0	78.24	2678.	0.	9558.	7455.	3.0
14.40	1398.	0.	1618.	771.	3.0	81.28	2005.	0.	10670.	8609.	3.0
17.60	1727.	0.	1751.	744.	3.0	84.16	1398.	0.	11693.	9680.	3.0
19.04	1771.	0.	1915.	839.	3.0	87.36	1286.	0.	12267.	10317.	3.0
24.00	1499.	0.	2903.	1607.	3.0	92.16	1545.	0.	12701.	10865.	3.0
25.92	1433.	0.	3246.	1872.	3.0	95.68	1735.	0.	13020.	11282.	3.0
28.48	1495.	0.	3554.	2080.	3.0	97.28	2988.	0.	11998.	10309.	3.0
31.20	1401.	0.	4041.	2469.	3.0	99.68	2297.	0.	13035.	11424.	3.0
36.32	1600.	0.	4581.	2844.	3.0	104.48	3235.	0.	12790.	11353.	3.0
39.68	2153.	0.	4514.	2682.	3.0	105.92	2726.	0.	13507.	12126.	3.0
42.40	2086.	0.	4974.	3074.	3.0	110.40	2149.	0.	14731.	13539.	3.0
46.40	2936.	0.	4701.	2715.	3.0	113.92	2190.	0.	15199.	14169.	3.0
47.52	2943.	0.	4856.	2849.	3.0	115.84	1824.	0.	15842.	14906.	3.0
50.08	2164.	0.	6005.	3953.	3.0	118.56	1827.	0.	16232.	15435.	3.0
53.44	2001.	0.	6653.	4554.	3.0	123.68	2066.	0.	16732.	16218.	3.0
56.64	1784.	0.	7332.	5198.	3.0	126.08	2991.	0.	16154.	15781.	3.0
61.28	2597.	0.	7189.	5022.	3.0	128.48	2706.	0.	16786.	16560.	3.0
63.04	2344.	0.	7697.	5523.	3.0	132.00	20000.	0.	0.	0.	3.0

TABLE 3.1-8 PROFILE TO AIRCRAFT (PSK)

Table 3.1-9 gives the analyzed aircraft locations for four typical airports with respect to the feederlink location.

TABLE 3.1-9

Analyzed Aircraft Locations

Location/ID	Coordinates		Distance * (Miles)	Azimuth * (Degrees)
	Latitude d-m-s	Longitude d-m-s		
Washington, DC (DCA)	38-51-07	77-01-16	63.63	83.92
Morgantown, WV (MGW)	39-38-34	79-54-59	69.65	314.41
Pittsburgh, PA (PIT)	40-29-29	80-13-54	122.38	326.86
Dublin, VA (PSK)	37-08-14	80-40-43	132.00	225.81

* Note that the airport will be along the same azimuth with a distance greater by approximately 23 miles than what is indicated for the aircraft.

The predicted over-the-horizon losses (for 80 percent of the time) for the paths from Williamsville, VA to the airport and aircraft are presented in Table 3.1-10.

TABLE 3.1-10

OH Losses to Airport and Aircraft

Location	OH Losses to Airport (dB)	OH Losses to Aircraft (dB)
Washington, DC (DCA)	64.2	28.36
Morgantown, WV (MGW)	3.2	0 (LOS)
Pittsburgh, PA (PIT)	55.8	28.63
Dublin, VA (PSK)	1.2	0 (LOS)

LOS: Line-of-Sight

Initially, in order to evaluate potential interfering signal level at the aircraft no terrain blockage was considered. This was achieved as follows:

$$I_R = P_{FL} + G_{FA} - FSL \qquad (1\text{-}3)$$

Where,

I_R is the interference level at the aircraft (no blockage) (dBW/4 kHz)

P_{FL} is -16 dBW/4 kHz or -0.26 dBW/150 kHz

G_{FA} is the gain of the feederlink antenna towards the aircraft based on actual elevation angle to aircraft and 32-25 log θ. The discrimination angle of 10 degrees minus the elevation angle to the aircraft. Figure 3.1-6 presents a diagram of the parameters considered in this analysis.

$$FSL = 96.6 + 20 \log (5.150) + 20 \log D_A \text{ (dB)} \qquad (1\text{-}4)$$

5.150 GHz is mid-band frequency

D_A is distance in statute miles from feederlink to aircraft along flat earth, since $D_A \approx D_F$

After the signal level to the aircraft was determined, the appropriate over-the-horizon losses were included to determine the potential interference level at the aircraft. The modified interference power is given by the following equation:

$$I_A = I_R - OH \text{ (dBW/4 kHz)} \qquad (1\text{-}5)$$

Where,

OH is the over-the-horizon or other losses. I_R is calculated by Equation (1-3).