APPENDIX F

TROPOSPHERIC SCATTER EQUATIONS

This appendix contains appropriate forms to be used in reference to a Feasibility and System Design Study.

MICROWAVE PATH DATA CALCULATIONS

No.	Item	Unit				
1	SITE					
2	LATITUDE					
3	LONGITUDE					
4	ELEVATION	Ft.				
5	TOWER HEIGHT	Ft.				
6	TOWER TYPE					
7	AZIMUTH FROM TRUE NORTH.					
8	PATH LENGTH	Mi.				
9	PATH ATTENUATION	dB				
10	RIGID WAVEGUIDE	Ft.				
11	FLEXIBLE WAVEGUIDE	Ft.				
12	WAVEGUIDE LOSS	dB				
13	CONNECTOR LOSS	dB				
14	CIRCULATOR OR HYBRID LOSS	dB				
15	RADOME LOSS, TYPE*	dB				
16	NEAR FIELD LOSS	dB				
17	CLOSE COUPLING LOSS (DOUBLE PASS.)	dB				
18	TOTAL FIXED LOSSES	dB				
19	TOTAL LOSSES	dB				
20	PARABOLA HEIGHT	Ft.				
21	PARABOLA DIAMETER	Ft.				
22	REFLECTOR HEIGHT	Ft.				
23	REFLECTOR SIZE, TYPE	Ft.				
24	PARABOLA - REFLECTOR SEP.	Ft.				
25	NEAR FIELD GAIN	dB				
26	ANTENNA SYSTEM GAIN	dB				
27	TOTAL GAINS	dB				
28	NET PATH LOSS	dB				
29	TRANSMITTER POWER	dBm				
30	MED. RECEIVED POWER (± 2 dB)	dBm				
31	RECEIVER NOISE THRESHOLD	dBm				
32	THEORECTICAL RF C/N RATIO	dB				
33	FM IMP. THRESHOLD (dBa)	dBm				
34	FADE MARGIN (To FM Imp. Thresh.)	dB				
35	RELIABILITY SPACING†	%				
36	POLARIZATION ‡					
37	PROFILE NUMBER					

‡ V - Vertical, H - Horizontal

† F - Frequency Diversity, S - Space Diversity, N - Non-Diversity, Q - Space And Frequency Diversity

* U - Unheated, H Heated

(Reliability Figures Are For Rayleigh Distributed Fading Only)

CUSTOMER ____________________

PROJECT NO. __________ FREQUENCY ____________________

SYSTEM ____________________ EQUIPMENT __________

LOADING __________ dBm0 (__________ CHANNELS OF __________)

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DATE __________ ENGINEER ____________________ Sheet ____ of ____

Figure F-1. Microwave Path Data Calculation Sheet

PARAMETER	
DISTANCE d, km	
SCATTER ANGLE θ, MILLIRADIANS	
θ d RADIANS	
ATTENUATION FUNCTION F(θd) IN dB (FROM FIGURE 4-5)	
30 LOG f IN dB	
−20 LOG d IN dB	
F_o, H, AND A_a CONSIDERED NEGLIGIBLE	
L_{bsr} dB	

$L_{bsr} = 30 \text{ LOG } f - 20 \text{ LOG } d + F(\theta d) - F_o + H_o + A_a$; dB

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Figure F-2. Computation of Long Term Median Transmission Loss Tropospheric Scatter (for) Preliminary Design Purposes)

ANTENNA COUPLING LOSS (SCATTER LOSS)
$S = \frac{\alpha_o}{\beta_o}$ (FROM FIGURE 6-17)
$D_s = d - d_{LT} - d_{LR}$ km (FROM FIGURE 6-17)
$h_o = \frac{S \; D_s \; \theta}{(1+S)^2}$ km
THE HALF POWER BEAM WIDTH Ω OF A PARABOLIC ANTENNA IS APPROXIMATELY $\Omega = \frac{1222}{FB}$ MILLIRADIANS F = FREQUENCY IN GHz B = PARABOLA DIAMETER FEET (FROM FIGURE 6-14)
$\frac{\theta}{\Omega} =$
SCATTER LOSS Lgp (FROM FIGURE 6-23) AIAA231

Figure F-3. Antenna Coupling Loss (Scatter Loss)

$L_{bsr} = 30 \text{ LOG } f - 20 \text{LOG } D + F(\theta d) - F_o + H_o + A_a$ dB

θd IN RADIANS		
PATH ASYMMETRY $S = \frac{\alpha_o}{\beta_o} =$		
ATTENUATION FUNCTION $F(\theta d)$ IN dB FROM FIGURE 8-6, 7, 8, OR 9		
30 LOG F IN dB =		
− 20 LOG d IN dB =		
$h_o = \frac{S \ d \theta}{(1+S)^2}$ IN km		
$r_1 = 41.92 \ \theta f \ h_{te} =$		
$r_2 = 41.92 \ \theta f \ h_{te} =$		
$q = \frac{r_2}{s r_1} =$		
η_s FROM FIGURE 6-22		
$H_o = \frac{H_o(r_1) + H_o(r_2)}{2} + \Delta H_o$ IN dB $H_o(r_1)$ & $H_o(r_2)$ FROM FIGURE 8-10 ; ΔH_o FROM FIGURE 8-11		
$D_s = d - d_{Lt} - d_{Lr}$ IN km		
$L_1 = \frac{S \ D_s \theta}{(1+S)^2}$ IN km		
$F_o = 1.086 \left(\frac{\eta_s}{h_o}\right)(h_o - h_1 - h_{Lt} - h_{Lr})$ dB		
A_a FROM FIGURE 4-6		
L_{bsr}		

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Figure F-4. Computation of Long Term Median Transmission Loss Tropospheric Scatter (for Design Purposes)

(EXISTING TROPOSCATTER PATH)

$d =$

$a =$

$h_{ts} =$ $h_{Lt} =$ $h_{te} =$ $d_{Lt} =$ $d_{st} =$	$h_{rs} =$ $h_{Lr} =$ $h_{re} =$ $d_{Lr} =$ $d_{sr} =$
$\theta_{et} = \frac{h_{Lt} - h_{ts}}{d_{Lt}} - \frac{d_{Lt}}{2a}$	$\theta_{er} = \frac{h_{Lr} - h_{rs}}{d_{Lr}} - \frac{d_{Lr}}{2a}$
$x = \frac{d}{2a} + \frac{h_{ts} - h_{rs}}{d}$	$y = \frac{d}{2a} - \frac{h_{ts} - h_{rs}}{d}$
$\theta_{ot} = \theta_{et} + \frac{d_{Lt}}{a}$	$\theta_{or} = \theta_{er} + \frac{d_{Lr}}{a}$
$\Delta\alpha \cong$ FROM FIGURES 6-18 AND 6-19	$\Delta\beta \cong$ FROM FIGURES 6-18 AND 6-19
$\alpha_o = \theta_{et} + x + \Delta\alpha_o$	$\beta_o = \theta_{er} + y + \Delta\beta_o$
$\theta_{00} = \theta = \alpha_o + \beta_o$	AIAA 233

Figure F-5. Tropospheric Path Angle Computations (Milliradians)