Table 4: Calculation Results for Space-to-Earth Interference from User Satellites into LMCS Receivers in the 26 GHz Band

Interfered-with LMCS Link	Wanted Type of Traffic	Receiver Antenna Elevation	Rain Condition (Rain/No-Rain) (dB)	Margin with no Interference (dB)	Margin with Interference (dB)	Margin Degradation (dB)
LMCS 'A'	1.544 kb/s	-1.9°	No Rain	18.5	18.44	0.06
Sub-to-Hub		-1.9°	Rain	4.5	4.45	0.05
Hub-to-Sub	18 MHz TV/FM	+1.0°	No Rain	2.0	1.00	1.00
		+1.0°	Rain	2.0	1.86	0.14
	18 MHz TV/FM	+3.0°	No Rain	2.0	1.73	0.27
		+3.0°	Rain	2.0	1.93	0.07
	18 MHz TV/FM	+5.0°	No Rain	2.0	1.69	0.31
		+5.0°	Rain	2.0	1.92	0.68
	18 MHz TV/FM	+5.0°	No Rain	2.0	1.32	0.68
		+5.0°	Rain	2.0	1.79	0.21
LMCS 'B'	Digital 1	-2.3°	No Rain	4.0	3.96	0.04
Sub-to-Hub	(52 MHz BW)	-2.3°	Rain	1.0	0.96	0.04
Hub-to-Sub	Digital #1 / #2	+1.0°	No Rain	4.0	1.84	2.16
	(52/5.2 MHz BW)	+1.0°	Rain	1.0	0.70	0.30
	Digital #1 / #2	+3.0°	No Rain	4.0	3.54	0.46
	(52/5.2 MHz BW)	+3.0°	Rain	1.0	0.91	0.09
	Digital #1 / #2	+5.0°	No Rain	4.0	3.00	1.00
	(52/5.2 MHz BW)	+5.0°	Rain	1.0	0.71	0.29
	Digital #1 / #2	+10.0°	No Rain	4.0	3.76	0.24
	(52/5.2 MHz BW)	+10.0°	Rain	1.0	0.76	0.24
Hub-to-Sub	TV/FM	+1.0°	No Rain	3.9	2.01	1.89
	(17 MHz BW)	+1.0°	Rain	0.9	0.60	0.30
	TV/FM	+3.0°	No Rain	3.9	3.44	0.46
	(17 MHz BW)	+3.0°	Rain	0.9	0.81	0.09
	TV/FM	+5.0°	No Rain	3.9	3.46	0.44
	(17 MHz BW)	+5.0°	Rain	0.9	0.81	0.09
	TV/FM	+10.0°	No Rain	3.9	2.90	1.00
	(17 MHz BW)	+10.0°	Rain	0.9	0.61	0.29

4.2 LMCS Transmitter Interfering into Inter-Satellite Service (Return Link) (Earth-to-space)

In calculating the aggregate interference from LMCS transmitters, it was necessary to calculate an estimate of the number of LMCS cells that would be visible in the 3 dB beamwidth of the receiving antenna of the DRS. The number of visible cells was a function of the average LMCS cell size (in km^2) in the DRS antenna beamwidth, the percentage coverage (implementation density) of the LMCS service and the total land area covered by the DRS beam. This third factor, coverage, depends upon the 3 dB beamwidth and the elevation angle that the centre of the satellite beam makes with the surface of the earth. In this case, given a 3 dB beamwidth of 0.21°, the pattern formed on the surface of the earth is an elongated ellipse for elevation angles down to 8.88°. For elevation angles below 8.88°, the far edge of the satellite beam overshoots the limb-of-the-Earth and thus the area on the Earth's surface covered by the satellite beam is less. For elevation angles between 0° and 10°, a circle of radius between 207 and 248 km^2 would be equivalent to the surface area within the DRS 3 dB receive beamwidth. Details of this surface area calculation are given on Figure 15.

The level of LMCS penetration will depend on the population density of the regions which will be served. Census data from the 1994 Rand McNally Commercial Atlas & Marketing Guide reveal that over 90 % of the population in the most heavily populated area of Eastern North America live on only 26 % of the land mass. Based on this figure, it was estimated that a worst case implementation density of 1 in 3 (or 33.3 %) in any area covered by the DRS spot beam would be a conservative value. The number of visible cells in a given coverage area can be determined by the expression:

$$\text{No. of LMCS Cells} = (1/3) \times \text{Coverage Area } (km^2)/\text{Average Cell Size } (km^2)$$

Interference from LMCS cells outside the 3 dB DRS beamwidth will also contribute to the aggregate interference level. Certain simplifications, however, were made to simplify the calculation of aggregate interference into the DRS receiver. Rather than aggregating the off-axis contributions from LMCS cells outside the DRS 3 dB beamwidth, which would at most be equivalent to the aggregate interference within the 3 dB beamwidth, it was assumed that all LMCS interferers were within the 3 dB beamwidth of the DRS. Furthermore, the receiving satellite antenna was assumed to have maximum gain across its entire 3 dB beamwidth. A 1.2 dB was subtracted from the maximum to account for the that fact that the average gain across the 3 dB beamwidth, assuming a $(\sin(x)/x)^2$ beam shape, is 1.2 dB lower than the maximum.

Interference into the DRS receiver may be due to aggregate levels from both hub stations and subscriber terminals depending on how spectrum is allocated to each. When aggregating interference from LMCS hub stations, the effect of scattering from the ground may be significant and must be considered. To simplify the analysis, given a large number of simultaneous interferers in the 3 dB beamwidth, the aggregate interference from all visible cells can be calculated by treating all interference sources as Additive White Gaussian Noise (AWGN).

Scatter from the ground had to be taken into consideration as a potentially significant contributor to the resultant interference received by the DRS given that the peak radiation from hub transmitters would be directed at some small negative angle toward the ground. The scatter, which was also treated as AWGN, was assumed to be radiated equally in all directions after having been reflected off a number of natural and man-made surfaces. A worst case diffuse scattering coefficient of -14 dB was assumed to be a representative average of all scattering surfaces while all reflecting surfaces were assumed to have an effective gain of 3 dBi (see CCIR Rep. 1008-1). Thus, the net effect of ground scatter was equivalent to an isotropic source radiating from the LMCS hub above the horizontal plane with an EIRP of 11 dB below the hub transmit power level. The effect of ground scatter has been ignored for the case of subscribers as the direct source(s) of interference. Since the elevation angles of high gain subscribers will be predominantly positive, the interference from subscriber originated ground scatter is assumed to be negligible and thus was not considered in the analysis.

At the input to the satellite, both the resultant interference due to the direct interference and the scattered interference was calculated for slant paths of 0° to 90° in elevation. The I/N ratio was calculated using the resultant level of interference compared to the thermal noise of the satellite receiver in the worst 1 MHz reference bandwidth for all slant path elevation angles. An interference-to-thermal noise ratio objective for the DRS of -10 dB was taken from Doc. [7/9]. Hub and subscriber interferences were considered separately as it was assumed that any hub and subscriber in a given cell could not use the same 1 MHz of spectrum simultaneously.

4.2.1 LMCS Hub Transmitters Interfering into Inter-Satellite Service (Return Link)

i) Interference from LMCS 'A'

For the LMCS 'A' system having an average cell size of approximately 75.4 km², assuming a 33.3% "urban" implementation density, the number of cells within the DRS (-3 dB) main beam was over 495 for elevation angles (to the satellite) between 0° and 10°. The maximum number of cells in the main beam was approximately 852 at an elevation angle of 8.88°. Figure 16 shows the number of LMCS 'A' hub stations within the DRS main beam as a function of elevation angle to the DRS.

Under clear-sky conditions, the interference at the input to the DRS receiver was less than 10% of the satellite's system thermal noise for all elevation angles above 5°. For elevation angles below 5°, the peak interference level occurred at an elevation angle of around 2° where the margin was about -6 dB (ie. I/N = -4 dB). The duration of such interference events would depend upon the vertical directivity of the LMCS hub antenna and the altitude and inclination of the 'User' satellite from which the DRS is receiving. This duration would be longer for higher altitude satellites. Based on Report 1197 (Doc. 9D/TEMP/13), the maximum duration of such a degradation in

service would range from approximately 30 to 60 seconds depending on the actual orbital parameters of the 'User' satellite. The margin which can be expected at the DRS receiver under clear-sky conditions is shown as a function of the elevation angle to the DRS from the LMCS interferer in Figure 17.

Under rain faded conditions, since LMCS 'A' transmits without APC, aggregate interference at the input to the DRS receiver from the LMCS transmitters was less than under clear-sky conditions for all elevation angles. The margin which can be expected at the DRS receiver under rain-faded conditions is shown as a function of elevation angle to the DRS for the LMCS transmitters as interferers in Figure 18.

ii) Interference from LMCS 'B'

For the LMCS 'B' system having an average cell size of approximately 95.7 km^2, assuming a 33.3% 'urban' implementation density, the number of cells within the DRS (-3 dB) main beam was over 390 for elevation angles to the satellite between 0° and 10°. The maximum number of cells in the main beam was approximately 671 for an 8.88° elevation angle. Figure 19 shows the number of LMCS hub stations within the DRS main beam as a function of elevation angle to the DRS.

Under clear-sky conditions, aggregate interference due to the TV/FM version of the LMCS transmitters at the input to the DRS receiver was less than 10% of the satellite's system thermal noise (ie. I/N < -10 dB) for all elevation angles. The aggregate interference due to the digital version of the LMCS hub transmitters at the input of the DRS receiver was well within acceptable limits and maintained a minimum margin of approximately 12 dB better than the -10 dB I/N objective. To further illustrate the impact of digital modulation, the effect of increasing the implementation density to 100% was calculated to maintain a minimum margin of 7 dB in the worst case. The margins which can be expected at the DRS receiver under 'clear-sky' conditions are shown as functions of elevation angle to the DRS for the TV/FM LMCS hub transmitter and the digital LMCS hub transmitter as interferers in Figures 20 and 21, respectively assuming 33.3% implementation densities. Similarly, the margins expected for a digital LMCS hub transmitter having a 100% implementation density is shown in Figure 22.

Under rain faded conditions, given the assumptions on APC and fading due to rain on the interference path as stated in section 2.4, interference at the input to the DRS receiver from the two types of LMCS transmitters was less than under 'clear-sky' conditions for elevation below about 10°. The margins which can be expected at the DRS receiver under 'rain-faded' conditions are shown as functions of elevation angle to the DRS for the TV/FM and digital transmitters (33.3% and 100% densities) as interferers in Figures 23, 24 and 25, respectively.

4.2.2 LMCS Subscriber Transmitters Interfering into Inter-Satellite Service (Return Link)

Having established that interference from LMCS hub stations into the DRS under 'clear-sky' conditions was the worst case and knowing that 99% of all subscriber stations for both LMCS 'A' and 'B' had elevation angles below about 6° for the assumed geometries, aggregate interference from the subscriber terminals was calculated only for the 'clear-sky' case.

The calculation of an aggregate interference level from all the cells visible in the (-3) dB beamwidth of the Data Relay Satellite (DRS), requires that a number of assumptions be made regarding the following:

a) number of simultaneous subscriber transmissions
b) the duty cycle of subscriber transmissions
c) the azimuthal distribution of subscriber orientation
d) the distribution of subscriber terminals as a function of elevation angle.

The equivalent number of simultaneous subscriber transmissions was assumed to be one per LMCS cell. The transmission duty cycle for each subscriber was assumed to be 100% as a worst case. The average duty cycle for each subscriber would be much lower than 100% given assumptions regarding 'off-peak' and 'quiet time' periods. The azimuthal distribution was assumed to be uniform. The boresight elevation of the subscriber terminals was assumed to have distributions as depicted in Figures 7 and 8.

The interference level at the input to the DRS receiver, due to one interfering subscriber, was calculated in the same way as for an interfering hub knowing the gain of the subscriber toward the DRS. The number of cells in the main beam of the DRS was multiplied by the ratio of the 6 dB beamwidth of a typical subscriber to a full 360° arc to account for the probability that the one transmitting subscriber in a cell would be located on the azimuth toward the DRS. The distribution of subscriber terminals according to elevation angle was modelled by weighting the total number of cells visible in the DRS main beam according to the distributions of Figures 7 and 8. This method would be expected to yield a conservative estimate of the aggregate subscriber interference, assuming a 100% transmission duty cycle. Actual interference levels are anticipated to be 2 to 5 dB lower when considering the actual transmission duty cycles and the actual distribution of subscriber azimuths about the DRS azimuth.

i) Interference from LMCS 'A' Subscriber Terminals

The margin at the DRS receiver due to aggregate interference from LMCS 'A' subscriber terminals is shown as a function of elevation angle to the DRS in Figure 26.

ii) Interference from LMCS 'B' Subscriber Terminals

The margin at the DRS receiver due to aggregate interference from LMCS 'B' subscriber terminals is shown as a function of elevation angle to the DRS in Figure 27.

5.0 CONCLUSIONS

The feasibility of sharing the 25.25 - 27.5 GHz band between the inter-satellite service and the fixed service employing LMCS has been examined:

- In the space-to-Earth direction, the impact of interference from the low-Earth-orbiting ('User')satellites on LMCS systems will be negligible. The LMCS subscriber-to-hub links are relatively unaffected when subjected to Article 28 pfd due to the relatively low hub antenna gains coupled with high atmospheric attenuations toward the horizon in this band. The LMCS hub-to-subscriber link, however, has larger degradations but the link margins were still positive. LMCS 'B' receiving digitally modulated signals in the presence of interference did so with a minimal degradation in link margin. Thus, digital links were the most robust in the presence of interference.

- In the Earth-to-space direction, the impact of interference from both the LMCS hub stations and subscriber terminals will be within the interference objective of the receiving DRS for nearly all conditions. At low elevation angles to the DRS, hub stations for LMCS 'A' transmitting TV/FM, may exceed the DRS interference objective. The LMCS 'A' system exceeded the 10% criteria by up to 6 dB only when the DRS was below 5° in elevation and the LMCS 'A' cells were located in Rain Climatic Zone M. Given that the assumed implementation densities of 33.3% may be optimistic in the case of Zone M, interference from LMCS 'A' in Zone M will likely be within objectives. For climatic zones with less severe rain rates, the DRS interference objective is marginally exceeded. For example, in Zone K, the worst case I/N expected is -6 dB.

- The impact of interference from the subscriber terminals into the DRS is more difficult to estimate without analyzing the expected levels of return traffic from the subscriber terminals or the access method for allocation of bandwidth. Assuming that subscriber terminals would be randomly oriented in azimuth and assuming 100% transmission duty cycles, some worst case estimates of interference into the DRS were derived. LMCS 'A' subscriber terminals, in Zone M, were found to cause interference levels about 2 dB worse than the DRS interference objective for elevation angles below 5°. In practice, actual levels are expected to be well below this. Again, if less severe rain rate climatic zones were assumed, the DRS interference objectives are met. LMCS 'B'

subscriber terminals, in Zone M, did not exceed the DRS interference objective for any elevation angle. Given that LMCS 'B' subscriber terminals use APC, the interference in other climatic zones will vary insignificantly from Zone M.

- Based on the technical parameters typical of LMCS systems and ISS, sharing is feasible in both the space-to-Earth and the Earth-to-space directions.

- The Earth-to-space interference calculation results show that hub stations transmitting with digital modulation will result in greatly improved sharing with the ISS. Thus, it may be necessary to encourage the use of digital modulation to improve sharing conditions with the ISS at 26 GHz. As a consequence, greater spectrum efficiency is achieved by the fixed service.

Fig. 1: LMCS Cell Size and Hub Transmitter Power as a Function of Rain Climatic Zone (LMCS 'A')

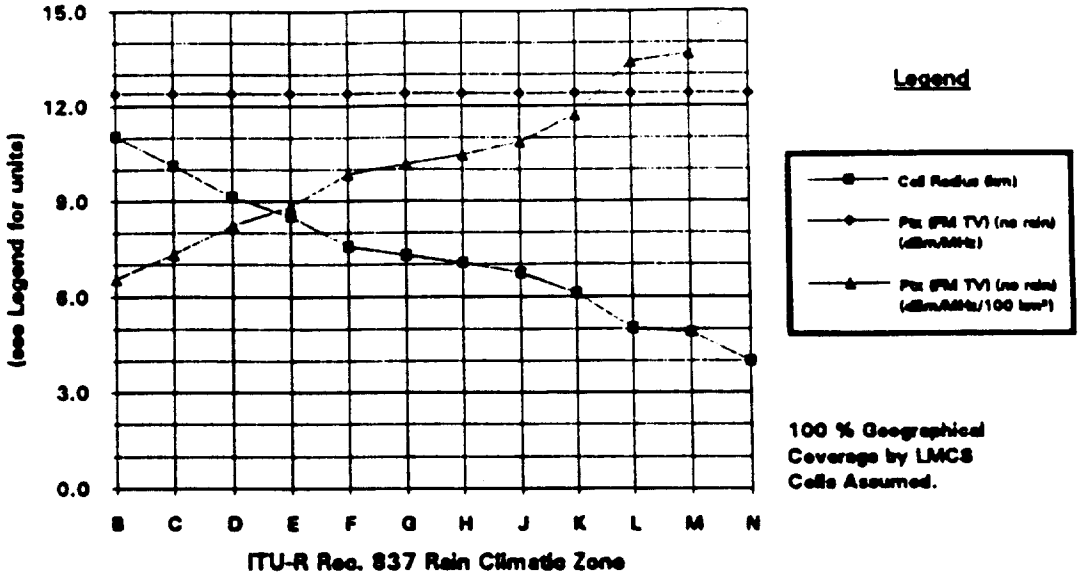
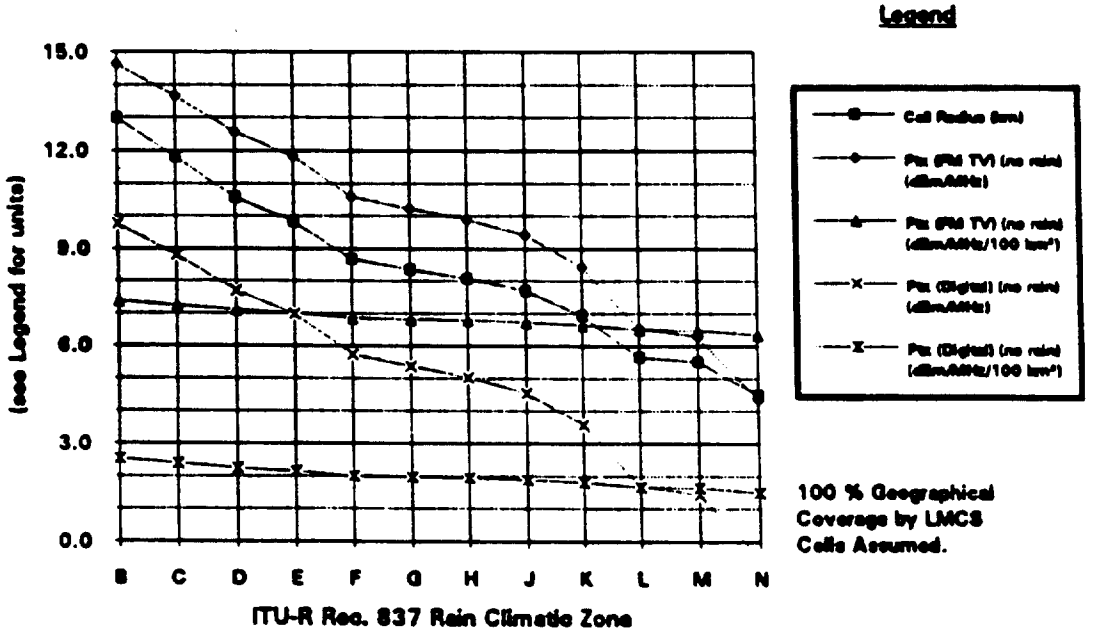


Fig. 2: LMCS Cell Size and Hub Transmitter Power as a Function of Rain Climatic Zone (LMCS 'B')



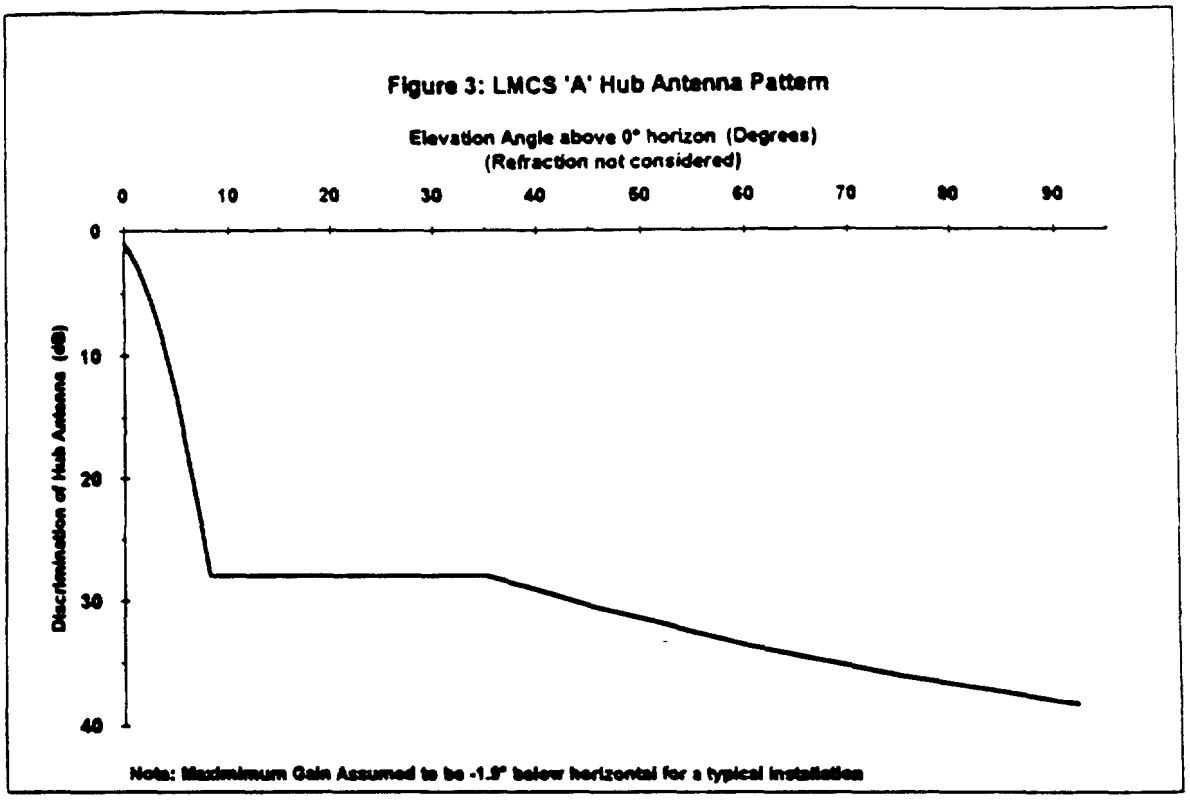


Figure 3: LMCS 'A' Hub Antenna Pattern
Elevation Angle above 0° horizon (Degrees)
(Refraction not considered)
0
10
20
30
40
50
60
70
80
90
0
10
20
30
40
Discrimination of Hub Antenna (dB)
Note: Maximum Gain Assumed to be -1.9° below horizontal for a typical installation

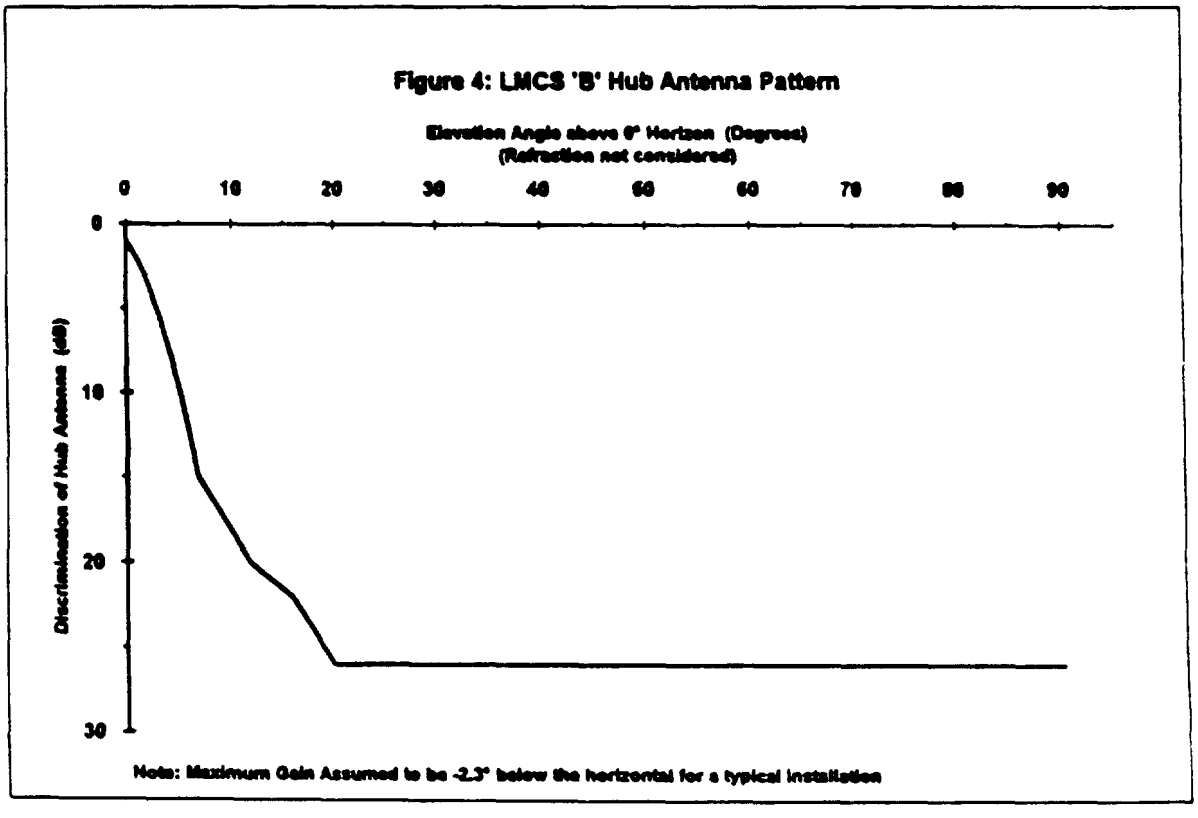


Figure 4: LMCS 'B' Hub Antenna Pattern
Elevation Angle above 0° Horizon (Degrees)
(Refraction not considered)
0
10
20
30
40
50
60
70
80
90
0
10
20
30
Discrimination of Hub Antenna (dB)
Note: Maximum Gain Assumed to be -2.3° below the horizontal for a typical installation

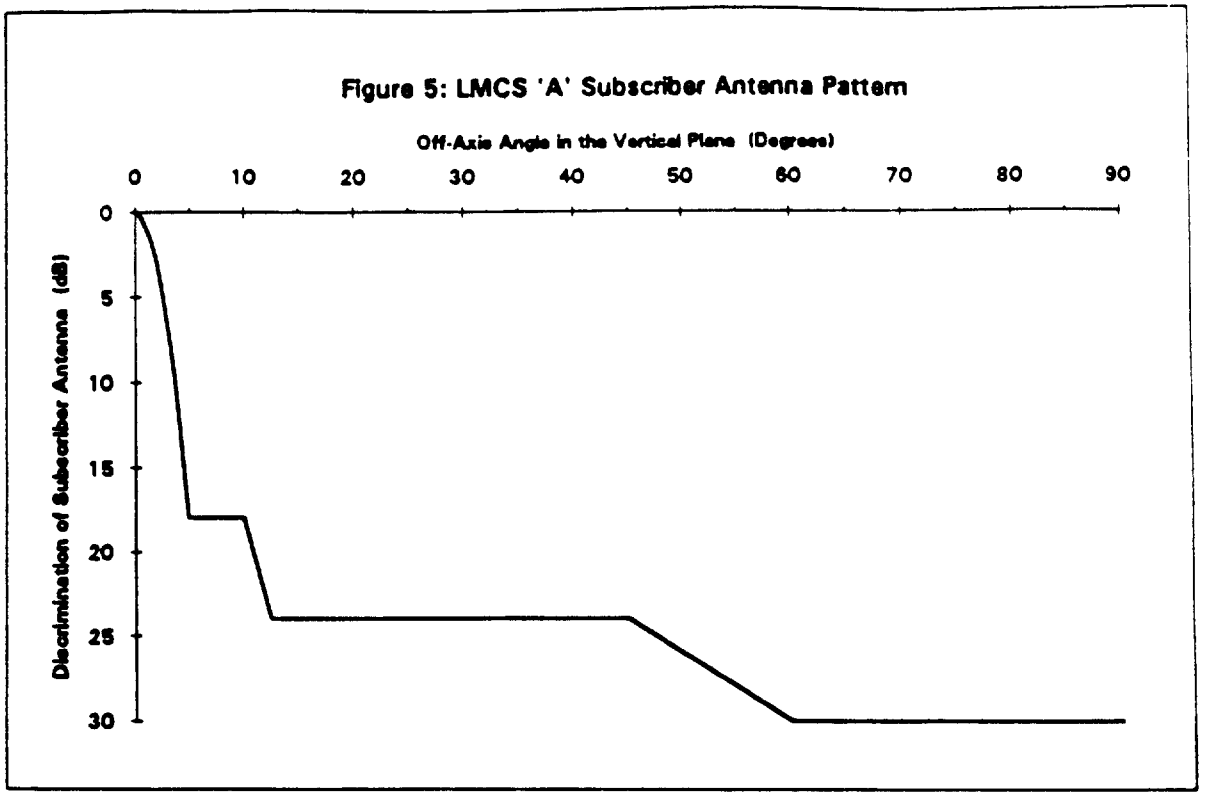


Figure 5: LMCS 'A' Subscriber Antenna Pattern
Off-Axis Angle in the Vertical Plane (Degrees)
0
10
20
30
40
50
60
70
80
90
Discrimination of Subscriber Antenna (dB)
0
5
10
15
20
25
30

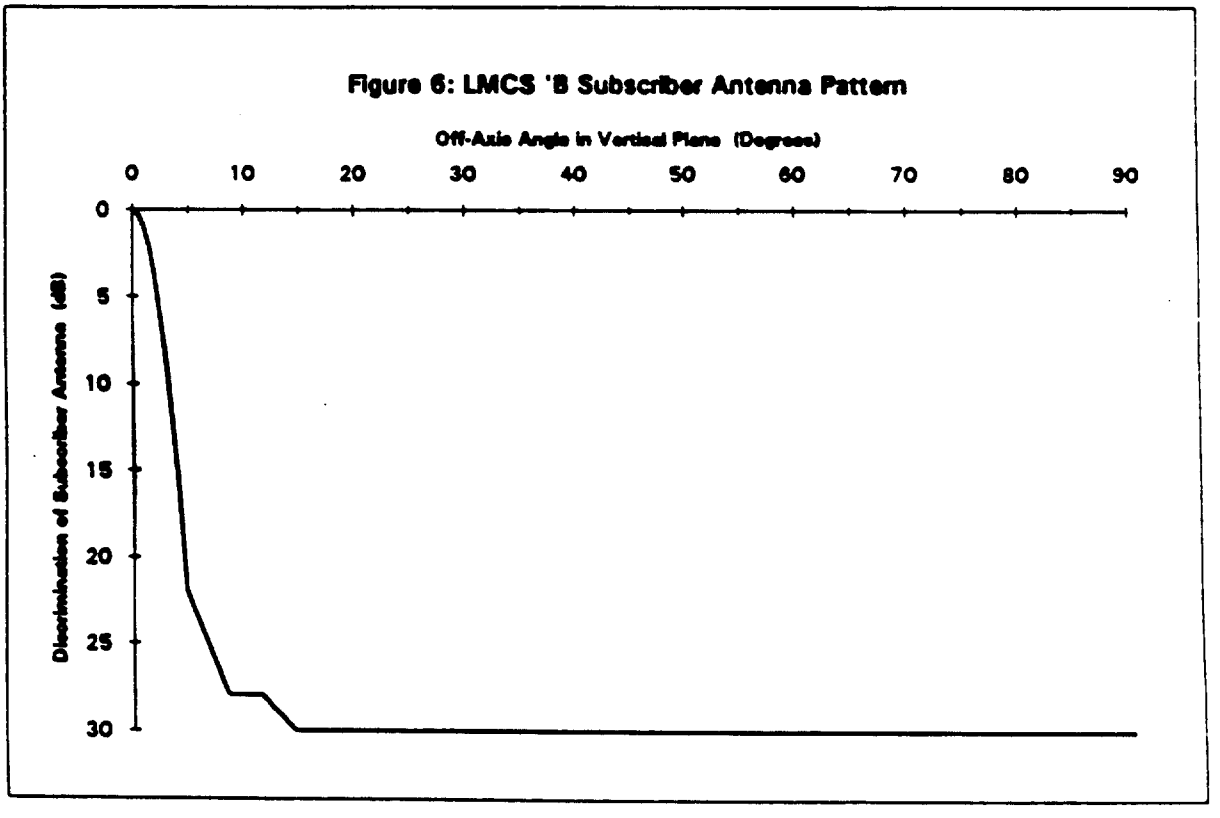


Figure 6: LMCS 'B Subscriber Antenna Pattern
Off-Axis Angle in Vertical Plane (Degrees)
0
10
20
30
40
50
60
70
80
90
Discrimination of Subscriber Antenna (dB)
0
5
10
15
20
25
30

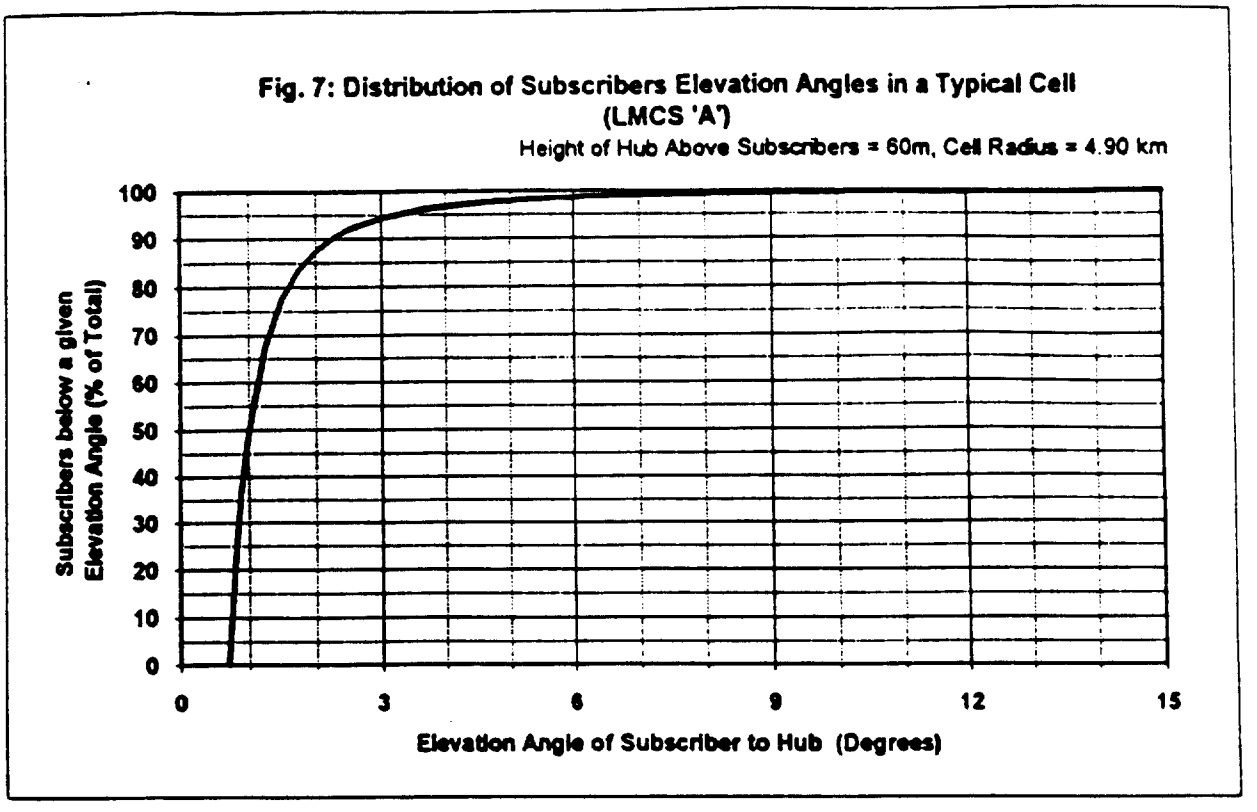


Fig. 7: Distribution of Subscribers Elevation Angles in a Typical Cell
(LMCS 'A')
Height of Hub Above Subscribers = 60m, Cell Radius = 4.90 km
Subscribers below a given Elevation Angle (% of Total)
100
90
80
70
60
50
40
30
20
10
0
0
3
6
9
12
15
Elevation Angle of Subscriber to Hub (Degrees)

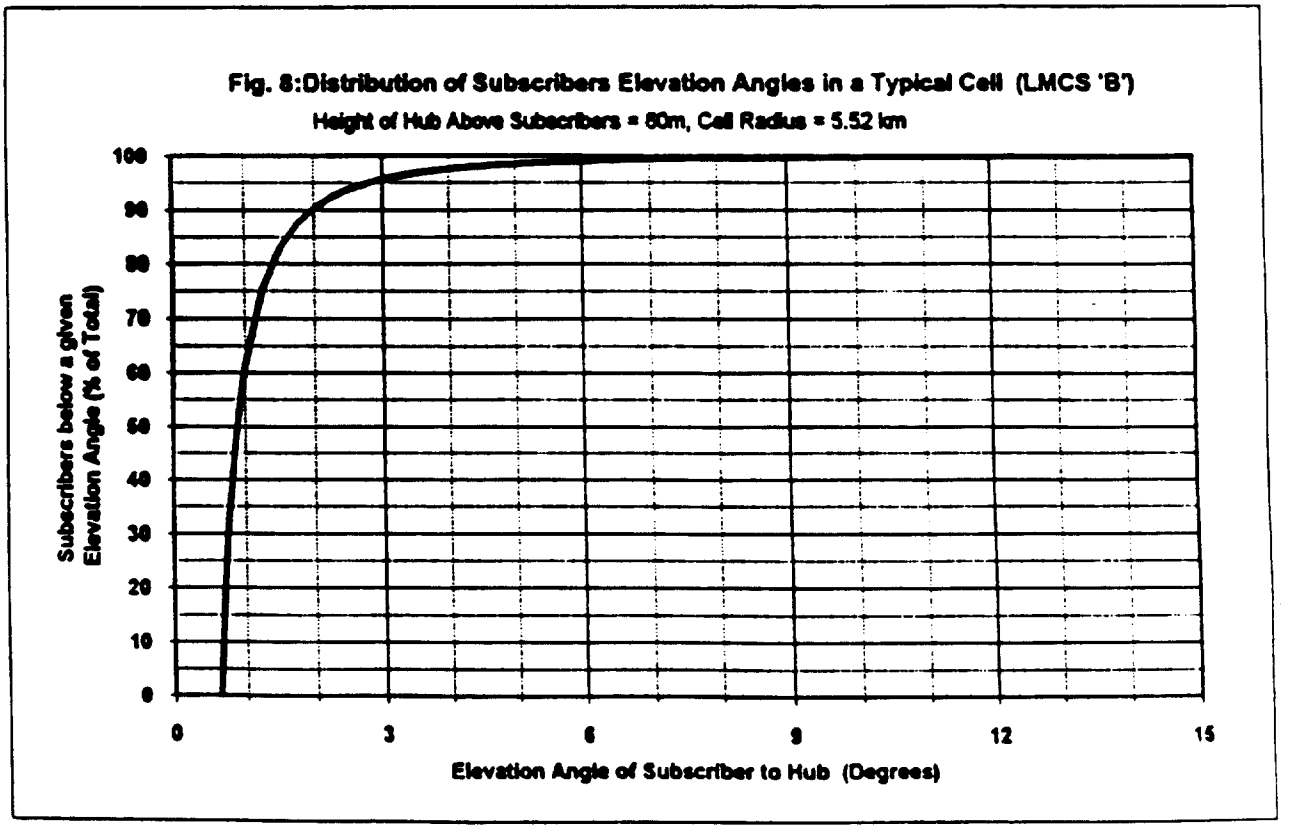


Fig. 8:Distribution of Subscribers Elevation Angles in a Typical Cell (LMCS 'B')
Height of Hub Above Subscribers = 60m, Cell Radius = 5.52 km
Subscribers below a given Elevation Angle (% of Total)
100
90
80
70
60
50
40
30
20
10
0
0
3
6
9
12
15
Elevation Angle of Subscriber to Hub (Degrees)

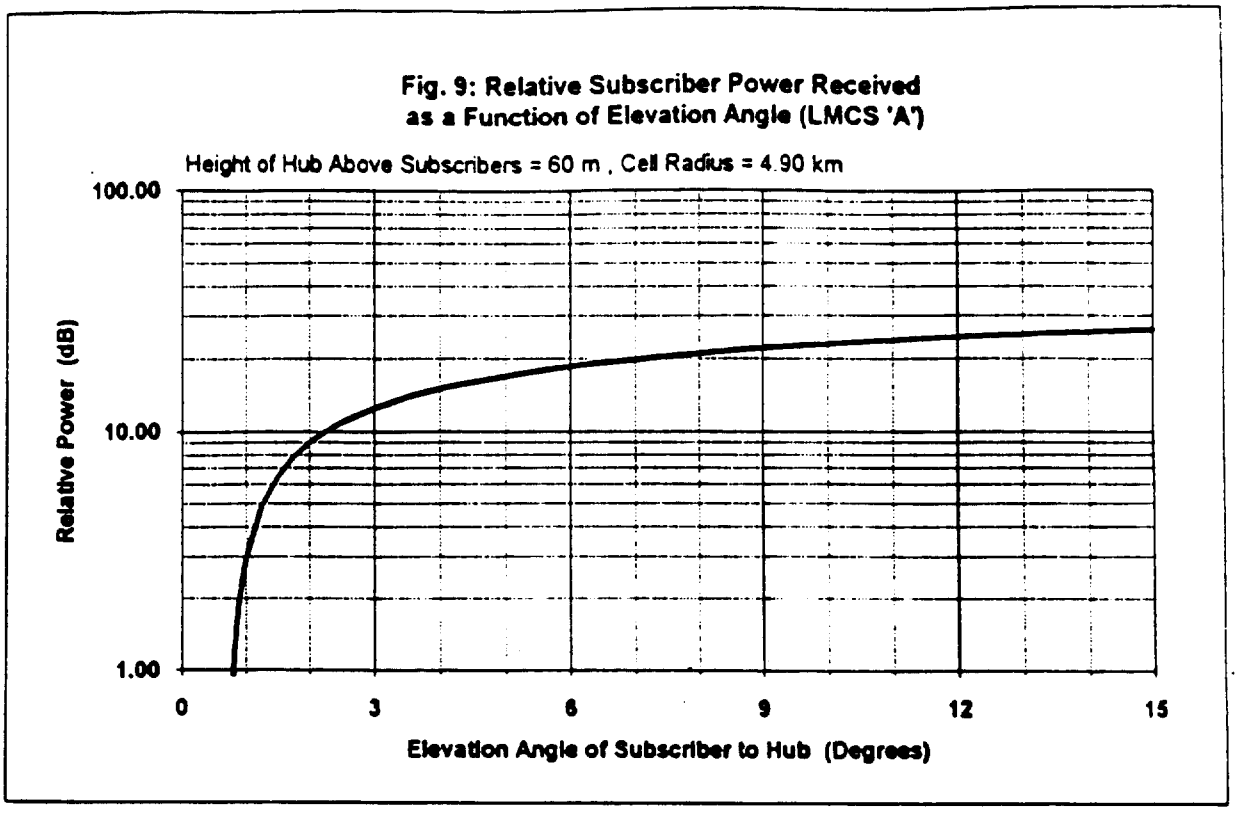


Fig. 9: Relative Subscriber Power Received
as a Function of Elevation Angle (LMCS 'A')
Height of Hub Above Subscribers = 60 m , Cell Radius = 4.90 km
100.00
10.00
1.00
Relative Power (dB)
0
3
6
9
12
15
Elevation Angle of Subscriber to Hub (Degrees)

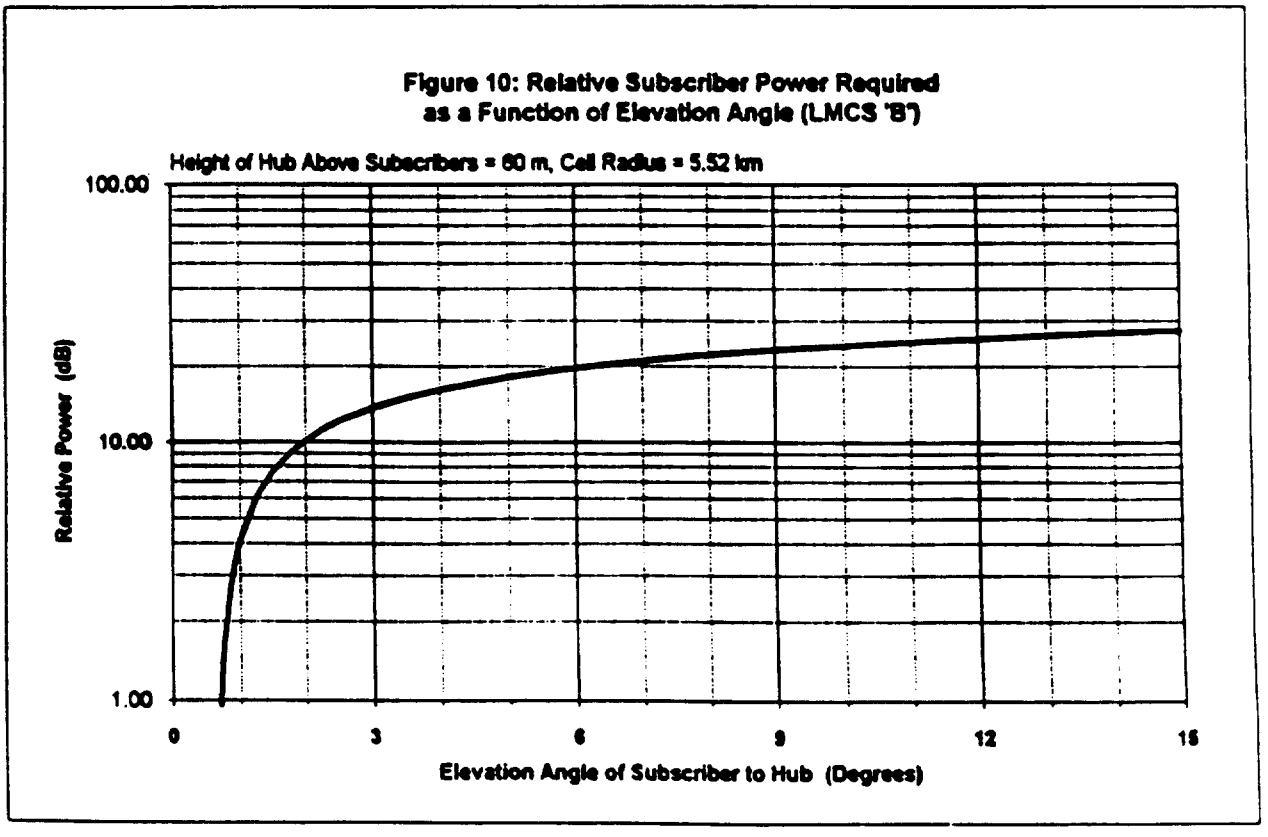
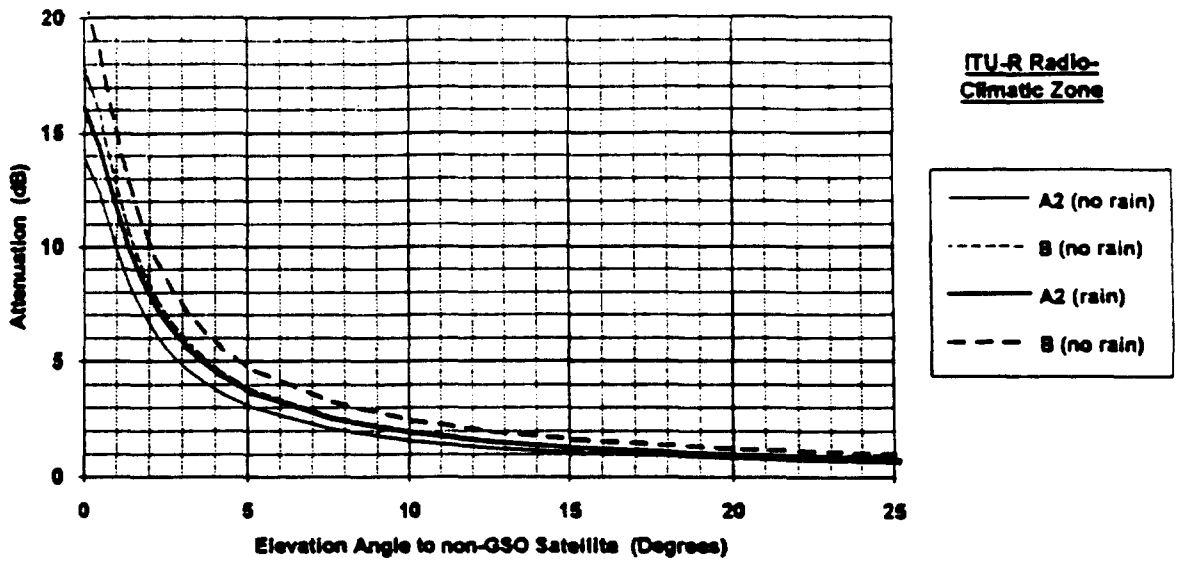


Figure 10: Relative Subscriber Power Required
as a Function of Elevation Angle (LMCS 'B')
Height of Hub Above Subscribers = 60 m, Cell Radius = 5.52 km
100.00
10.00
1.00
Relative Power (dB)
0
3
6
9
12
15
Elevation Angle of Subscriber to Hub (Degrees)

Fig. 11: Rec. ITU-R PN.676-1 Attenuation Due to Atmospheric Gases as a Function of Elevation Angle



Frequency = 26.375 GHz, Ground Elevation = 360 m, Pressure = 1013 hPa, Temperature = 15°

Fig. 12: Slant Path Rain Attenuation in Rec. ITU-R PN. 837 Zone M

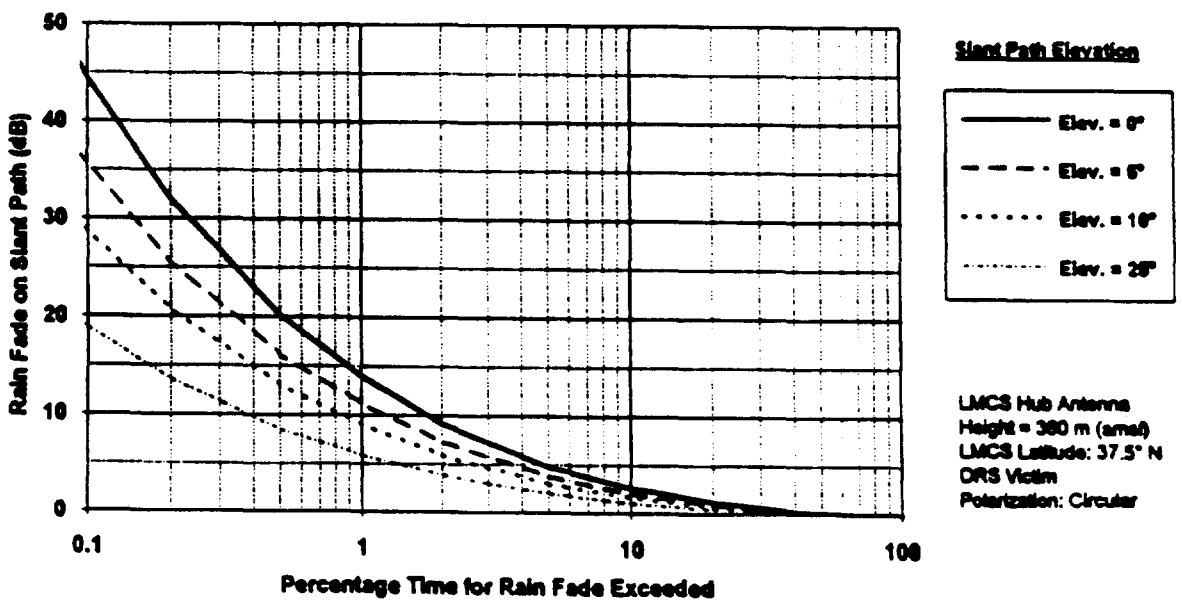


Fig. 13: Rec. ITU-R PN.618-2 Rain Attenuation for Slant Paths in Rec. ITU-R PN.837 Rain Climatic Zone M

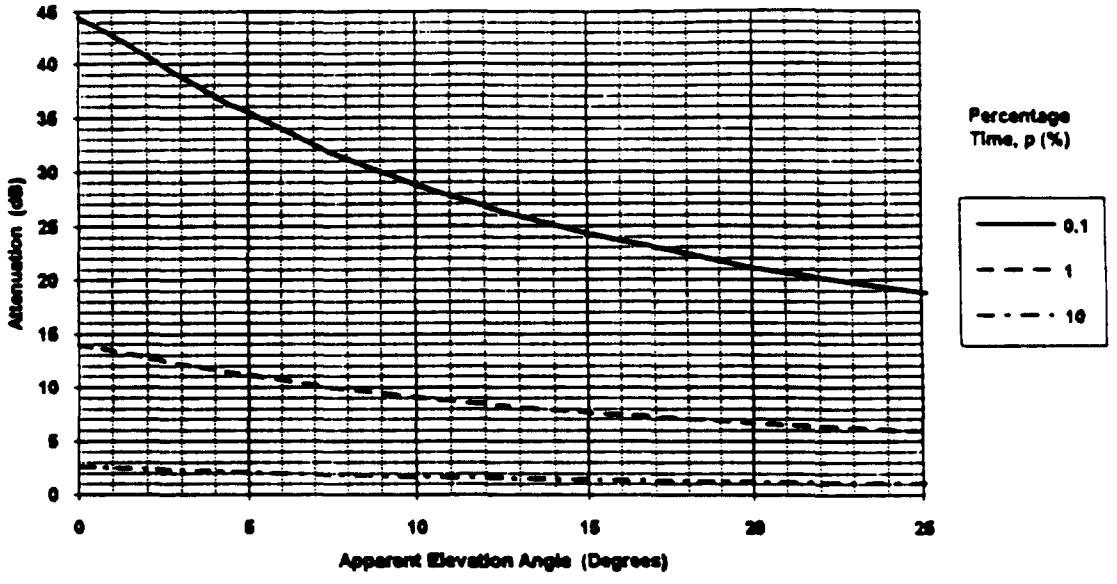


Fig. 14: Comparison of Worst Case Pfd with Pfd Derived from Practical Operational Parameters as a Function of LEO Satellite Elevation Angle

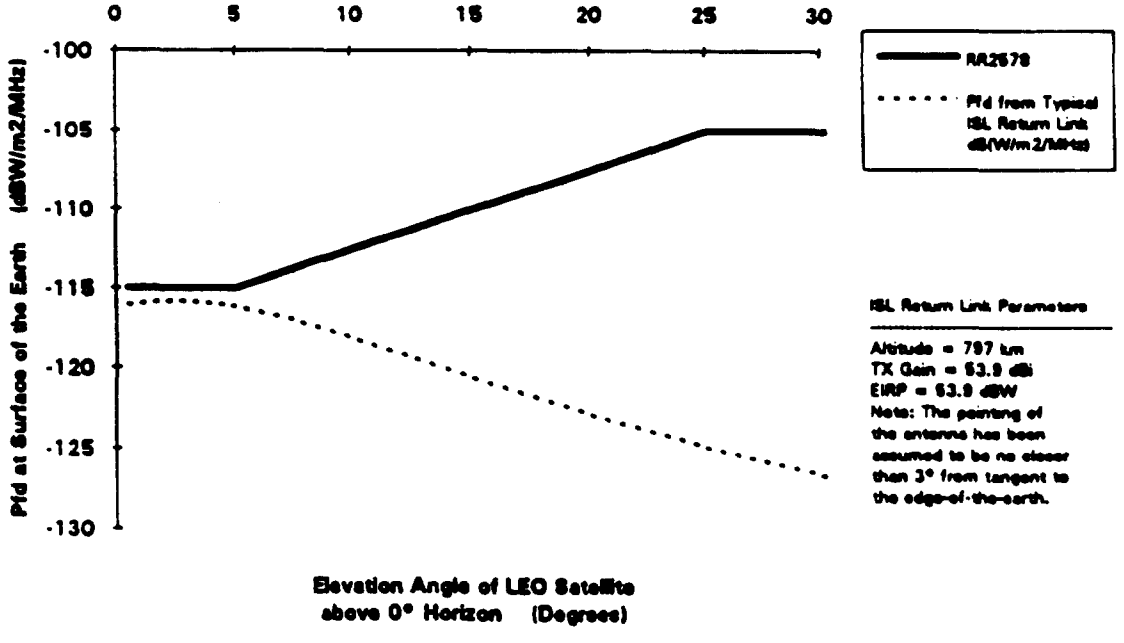
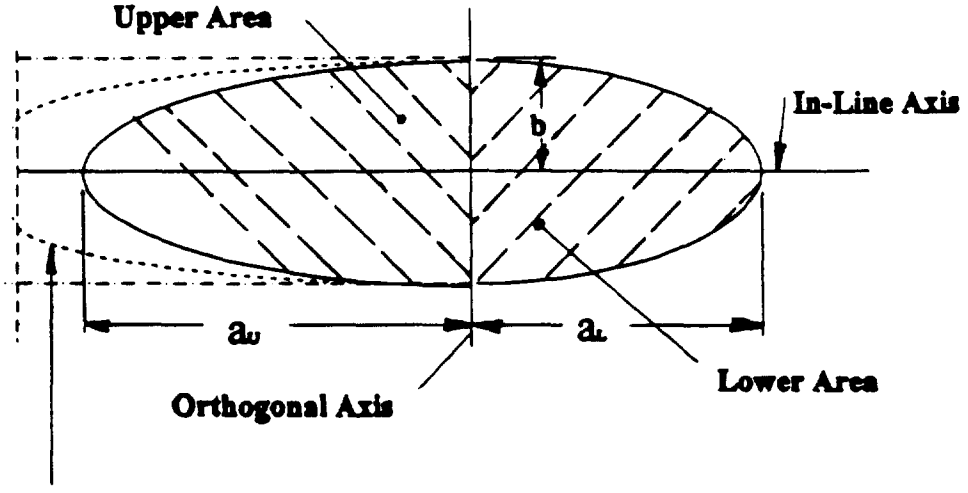


Fig. 15: Calculation of Earth's Surface Area Covered by DRS

Coverage Area Calculation of DRS SPOT Beam



Top of DRS beam overshoots the earth

Approximate Coverage Areas

Lower Area = (Pi/2) x a_L x b

Upper Area = (Pi /2)x a_U x b when top edge of satellite beam intersects the earth

= 2 x a_U x b when top edge of satellite beam overshoots the earth

a_U = half-major axis of top part of 'ellipse'
a_L = half-major axis of bottom part of 'ellipse'
b = half-minor axis of elongated 'ellipse'

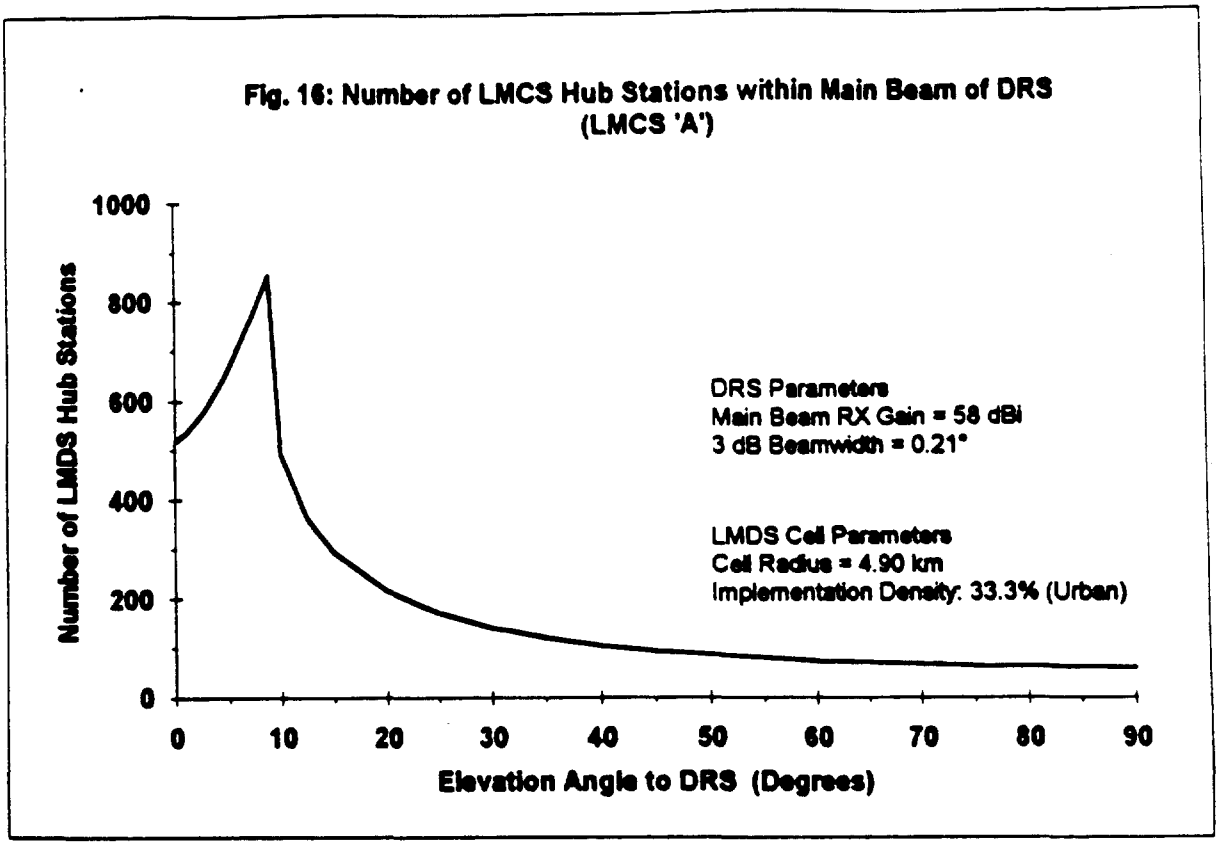


Fig. 16: Number of LMCS Hub Stations within Main Beam of DRS
(LMCS 'A')
Number of LMDS Hub Stations
1000
800
600
400
200
0
0
10
20
30
40
50
60
70
80
90
Elevation Angle to DRS (Degrees)
DRS Parameters
Main Beam RX Gain = 58 dBi
3 dB Beamwidth = 0.21°
LMDS Cell Parameters
Cell Radius = 4.90 km
Implementation Density: 33.3% (Urban)

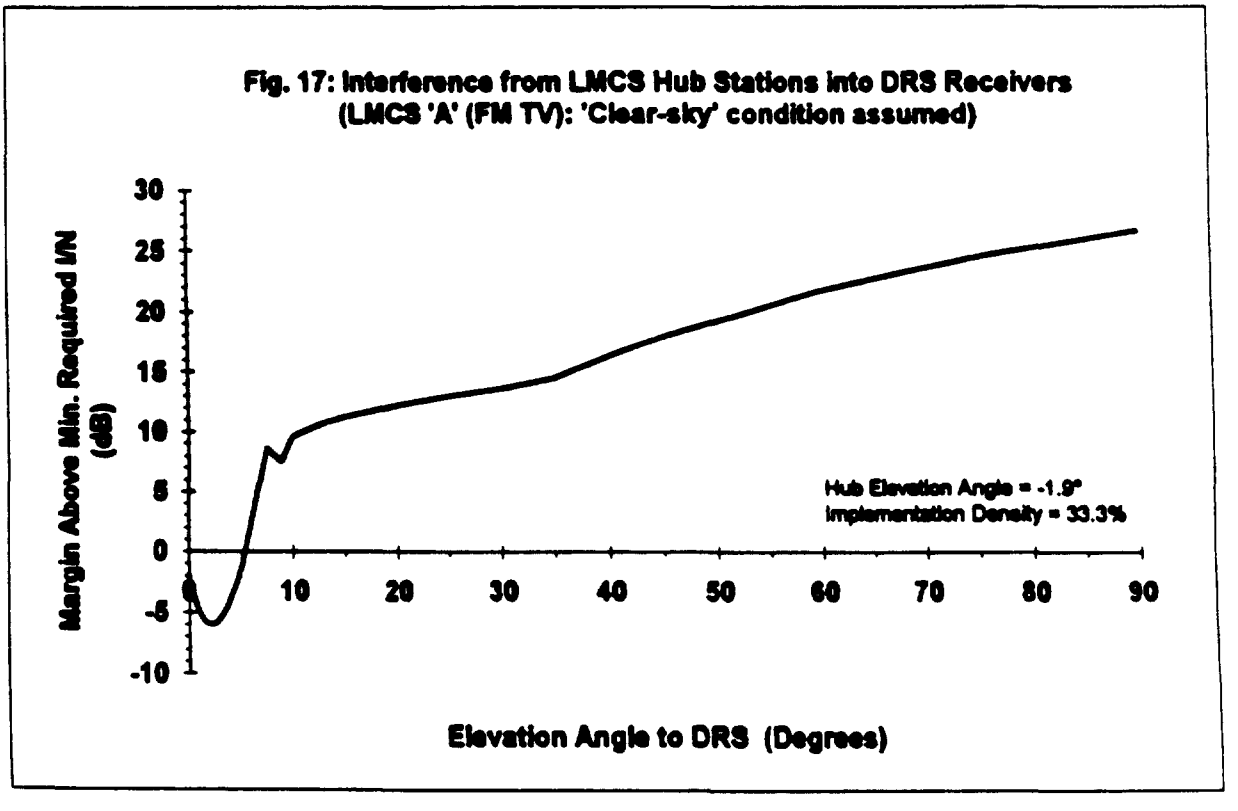


Fig. 17: Interference from LMCS Hub Stations into DRS Receivers
(LMCS 'A' (FM TV): 'Clear-sky' condition assumed)
Margin Above Min. Required I/N
(dB)
30
25
20
15
10
5
0
-5
-10
10
20
30
40
50
60
70
80
90
Elevation Angle to DRS (Degrees)
Hub Elevation Angle = -1.9°
Implementation Density = 33.3%

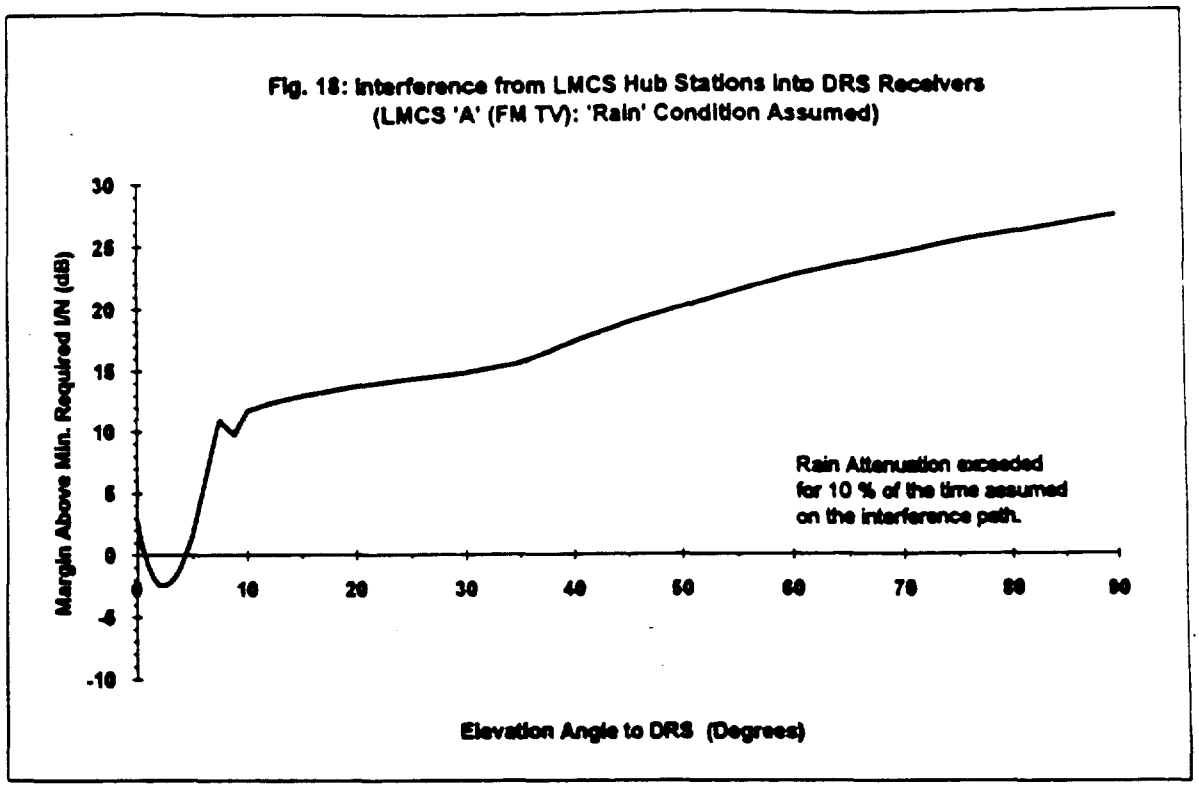


Fig. 18: Interference from LMCS Hub Stations into DRS Receivers (LMCS 'A' (FM TV): 'Rain' Condition Assumed)

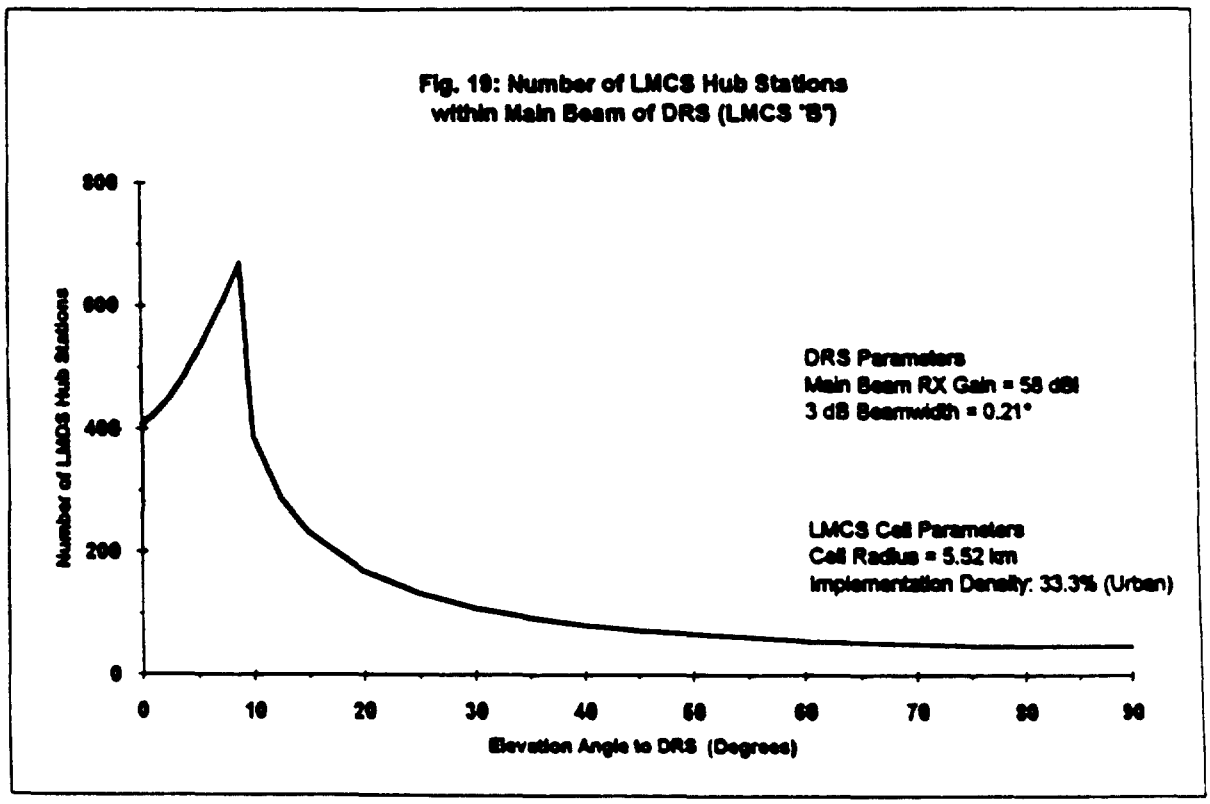


Fig. 19: Number of LMCS Hub Stations within Main Beam of DRS (LMCS 'B')

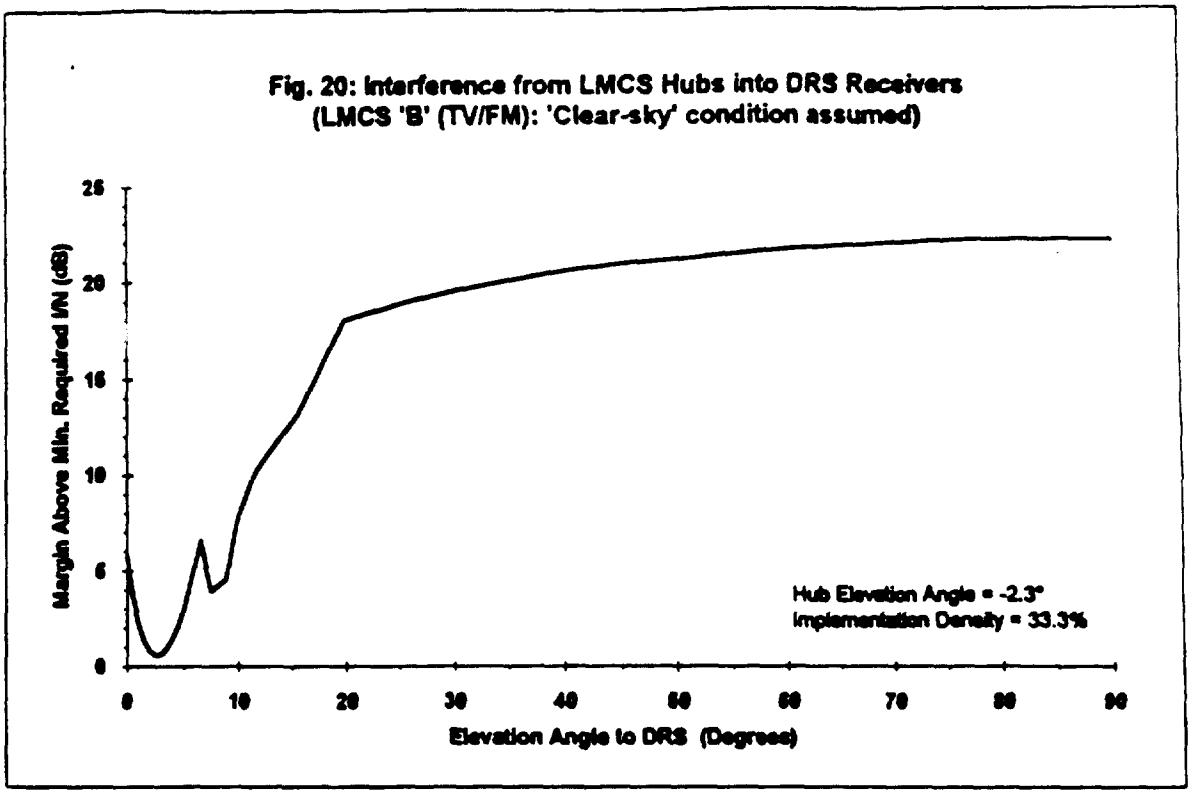


Fig. 20: Interference from LMCS Hubs into DRS Receivers
(LMCS 'B' (TV/FM): 'Clear-sky' condition assumed)

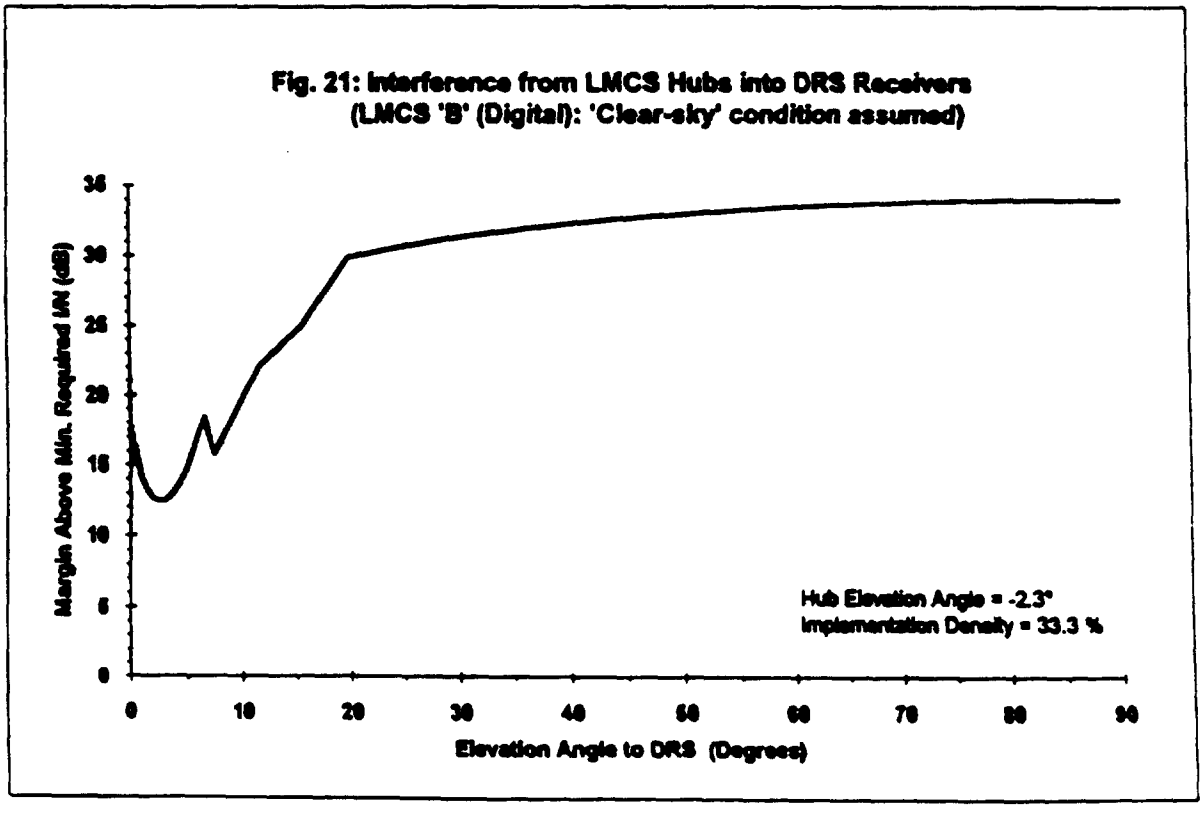


Fig. 21: Interference from LMCS Hubs into DRS Receivers
(LMCS 'B' (Digital): 'Clear-sky' condition assumed)

Fig. 22: Interference from LMCS Hubs into DRS Receivers
(LMCS B (Digital): 'Clear-sky' condition assumed)

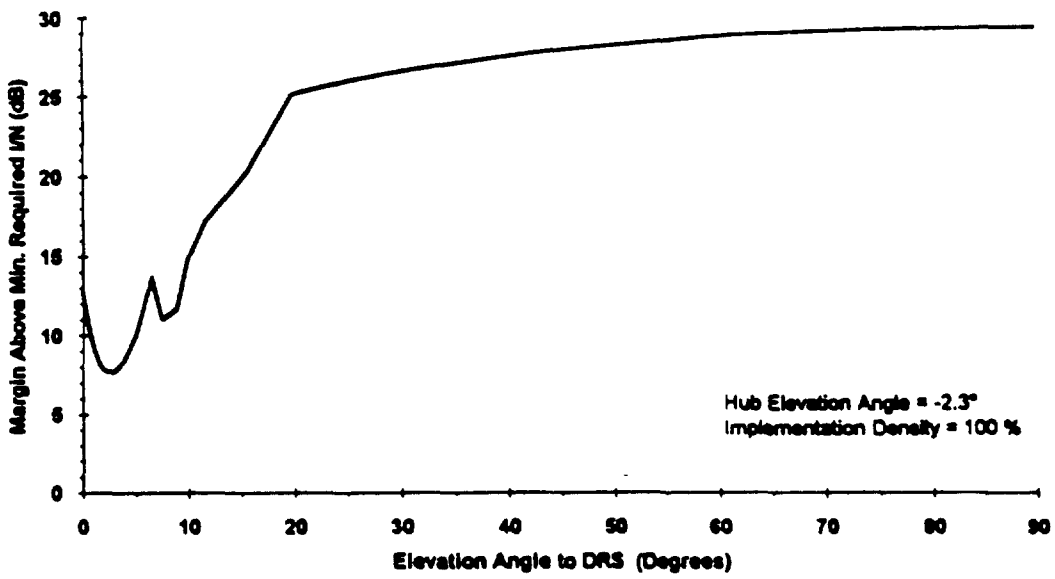


Fig. 23: Interference from LMCS Hubs into DRS Receivers
(LMCS B (FM TV): 'Rain' Condition Assumed)

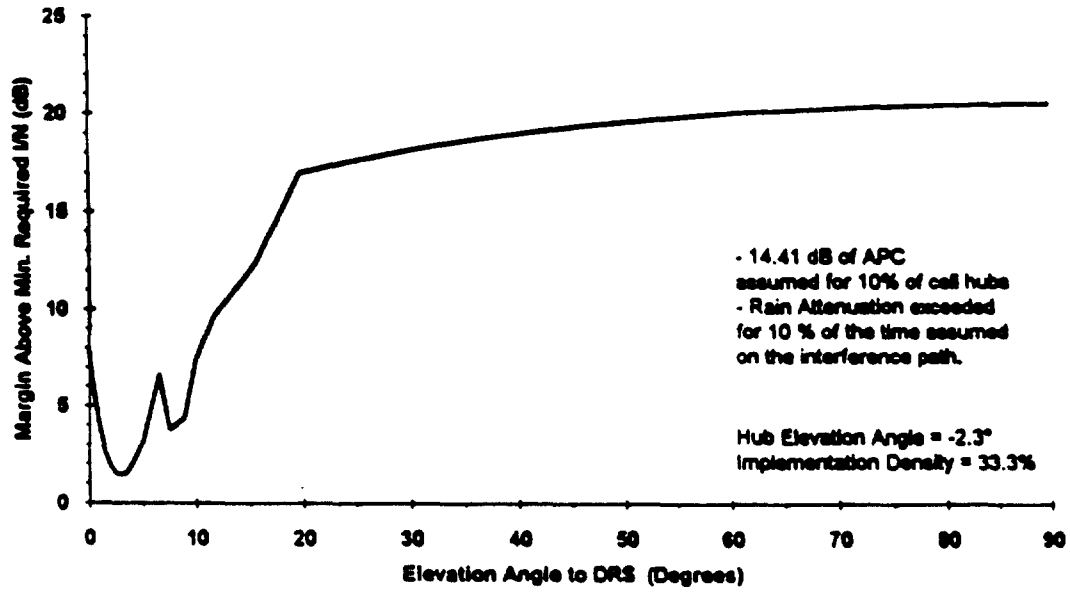


Fig. 24: Interference from LMCS Hubs into DRS Receivers
(LMCS 'B' (Digital): 'Rain' Condition Assumed)

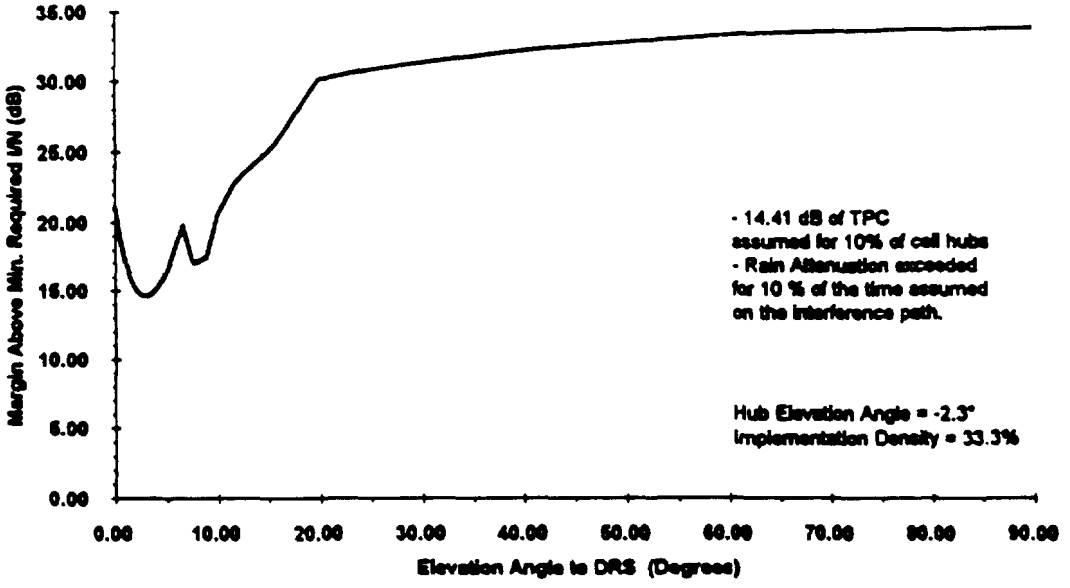


Fig. 25: Interference from LMCS Hubs into DRS Receivers
(LMCS 'B' (Digital): 'Rain' Condition Assumed)

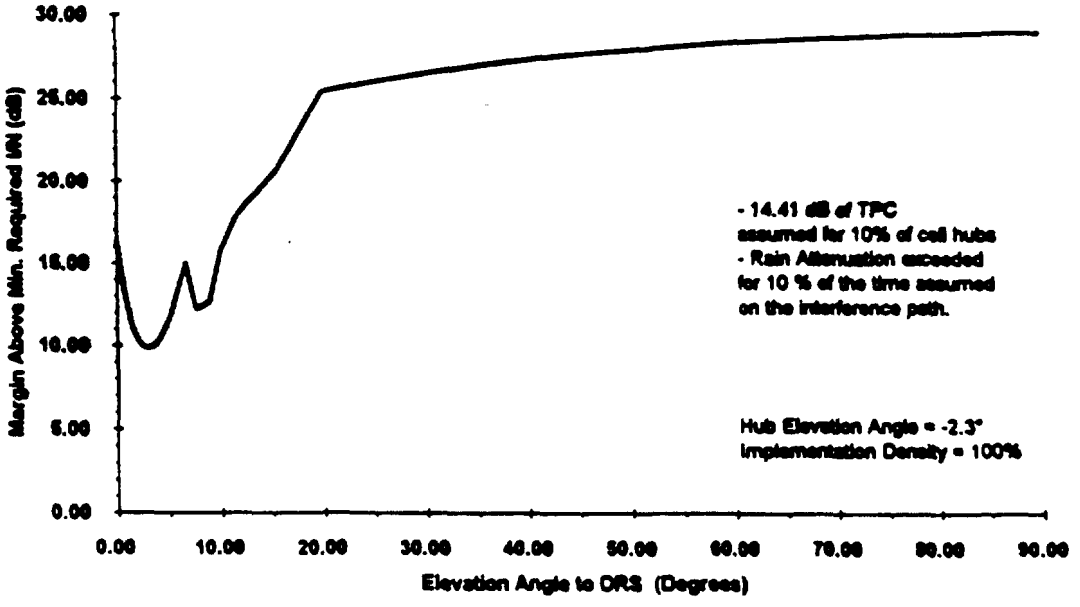


Fig. 26: Interference from LMCS Subscriber Terminals into DRS Receivers
(LMCS 'A' (Digital, 1.544 Mb/s): 'Clear-sky' condition assumed)

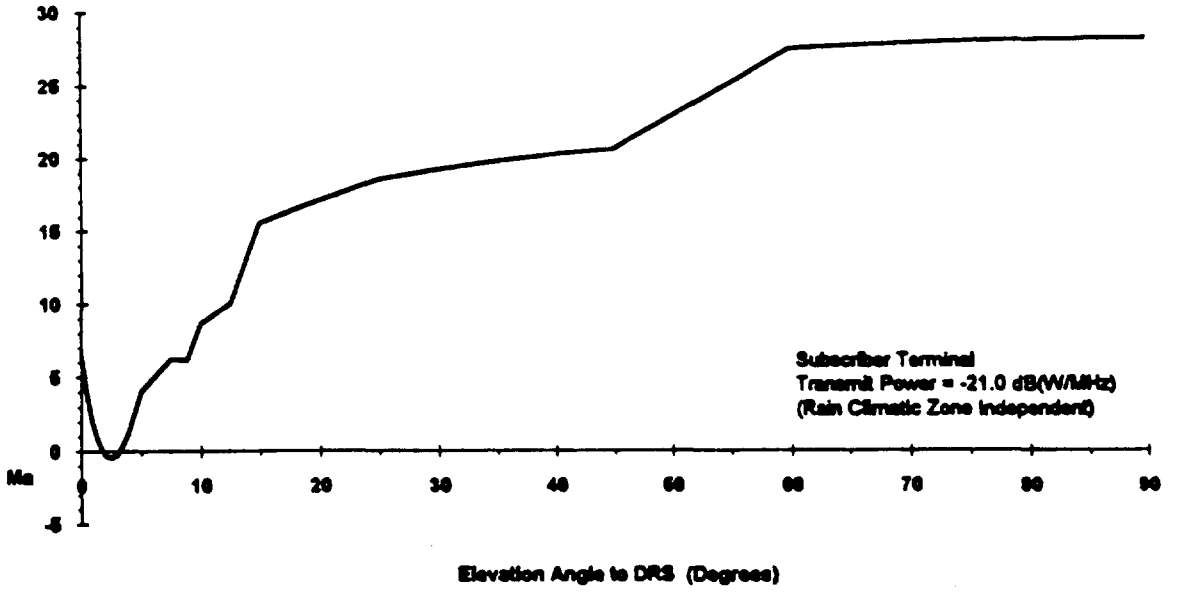
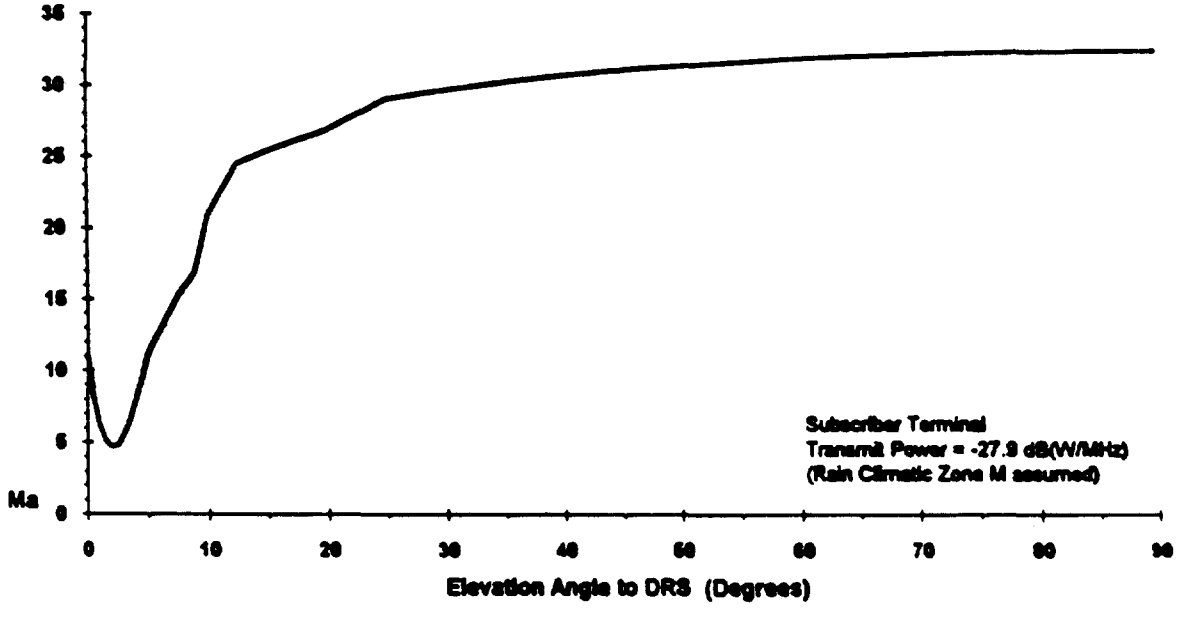


Fig. 27: Interference from LMCS Subscriber Terminals into DRS Receivers
(LMCS 'B' (Digital, 5.2 Mb/s): 'Clear-sky' condition assumed)



SFCG 5-39

Agence spatiale canadienne
6767, route de l'Aéroport
Saint-Hubert (Québec)
J3Y 8Y9

Canadian Space Agency
6767 route de l'Aéroport
Saint-Hubert, Quebec
J3Y 8Y9

10 November 1995

To all Members,

Subject: ***"On the Sharing of Portions of the Band 25.25-27.5 GHz Between the Proximity Links in the Inter-Satellite Service and Local Multi-point Communications Systems in the Fixed Service.***

Dear Colleagues,

Enclosed please find the contribution from Canadian Space Agency to SFCG-15, titled "On the Sharing of Portions of the Band 25.25-27.5 GHz Between the Proximity Links in the Inter-Satellite Service and Local Multipoint Communications Systems in the Fixed Service".

The document is being sent to all Members and Observers.

Best Regards,

A. R. Bastikar

Ref: wpdata\sfcg-doc.let

Canada

On the sharing of Portions of the Band 25.25-27.5 GHz Between the Proximity Links in the Inter-Satellite Service and Local Multipoint Communications Systems in the Fixed Service

Executive Summary

The Canadian Space Agency, in cooperation with other space agencies, is heavily involved in development of the space station. One of the items of considerable interest to Canada in this international activity is the implementation of proximity links for communication between the space station and remote locations as far away as 50 km from the space station. These are being developed in the frequency bands 25.25 - 25.55 GHz and 27.1 - 27.5 GHz.

A consideration being given in Canada to designating the fixed service in these bands to be used by Local Multipoint Communications Systems (LMCS). These systems may also be known as Local Multipoint Distribution Systems (LMDS). These systems are being designed in implemented in other bands as local Star networks with a hub and many peripheral user terminals with highly directive antennas. These local star networks are used for television distribution and for multimedia voice, data, and video communication over either simplex or full-duplex channels. These local star networks operate over short ranges with only a 4 to 12 km radius, depending on the rain conditions in the area of interest. A large metropolitan area is served by many such local networks. There is complete frequency reuse from one local network to another.

The problem addressed in this document is the potential for harmful interference between these competing uses of the 25.4 GHz and 27.3 GHz bands. The interference from proximity-link transmitters into LMCS receivers is constrained by Radio Regulation 2578 that limits the power-flux density (pfd) from proximity links to any point on the Earth's surface. The planned power levels and antenna characteristics of the proximity-link systems, as currently being planned, provide a pfd only fractions of a dB less than the maximum permitted by RR 2578. This means that the proximity link system designer cannot avoid harmful interference from LMCS systems increasing his transmitted power.

Under worst-case conditions, the interference-to-thermal-noise ratio in the proximity-link receiver from all LMCS systems in the proximity-link antenna's view would be about -5.1 dB, averaged over the bandwidth of a radio channel in the proximity link. This is equivalent to an increase in the proximity-link noise temperature of about 238° K. This amount of interference on a short - term basis of minutes as the space-station passes over a given area of the Earth's surface may be acceptable; it it equivalent to reducing the maximum operating range of the link by a few kilometres.

If, however, LMCS systems were implemented with higher power levels than the current systems being contemplated by WIC, or if there was also significant levels of inter-network interference from other fixed or other satellite networks, then the band would become of limited use to CSA in meeting their commitments to development of the space station. A point of concern is that there are LMDS systems under development with considerably higher power levels than considered in this study.

One way to avoid this potentially difficult inter-service sharing problem, if it is considered necessary to implement LMCS systems in the 25.25 - 27.5 GHz band, is to implement them in bands not used by proximity links. Additonally there may be problems in sharing LMCS systems with data-relay satellite systems that transmit data from satellites in Low-Earth orbit to a data-relay satellite in geostationary orbit.