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Satellite and
Radiocommunications Division
International Bureau

VIA HAND DELIVERY

May 20, 2004

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Marlene H. Dortch, Secretary
Federal Communications Commission
Office of the Secretary
c/o Natek, Inc.
236 Massachusetts Avenue, N.E.
Suite 110
Washington, DC 20002

Re: AvL Technologies, Inc.
Earth Station Application, FCC File No. SES-MOD-20040225-00277, E030130

Dear Sir or Madam:

Attached please find an original and (5) five copies of the Opposition to the Petition to Deny of AvL Technologies, Inc, on the Petition to Deny of SWE-DISH Satellite Communications Systems, Inc. a subsidiary of SWE-DISH Satellite Systems AB, of Sweden dated May 7, 2004.

Best regards,

William K. Coulter

William K. Coulter

Enclosures

AvL TECHNOLOGIES
130 Roberts St. Asheville, NC 28801 ph 828.250.9950 fx 828.250.9938

May 20, 2004

Marlene H. Dortch, Secretary
Federal Communications Commission
Office of the Secretary
c/o Natek, Inc.
236 Massachusetts Avenue, N.E.
Suite 110
Washington, DC 20002

Re: AvL Technologies, Inc.
Earth Station Application, FCC File No. SES-MOD-20040225-00277
E030130

Dear Ms. Dortch:

AvL Technologies, ("AvL") herein provides its Opposition to the Petition to Deny of SWE-DISH Satellite Communications (SWE-DISH), dated May 7, 2004 in the above-referenced file.

AvL believes it has submitted an accurate and complete demonstration of compliance with all applicable Commission rules for the AvL Models 1000, 960 and 750 antennas of less than 1.2M diameter. AvL would be pleased to supply any additional information requested by the FCC. The Petition to Deny by SWE-DISH is purely an effort to take advantage of the Commission's rules and to restrain the trade of AvL, and it should be rejected immediately by the FCC as failing to set forth any basis for delaying a prompt grant.

The FCC will find that AvL has never stated that any application of SWE-DISH, or any other similarly situated provider, should be denied, but only offered technical comments for consideration to assure that harmful interference is not caused by non-conforming antennas of less than 1.2M in diameter which interference could harm the development of this potential new area of commerce for the U.S. satellite communications industry.

However, since SWE-DISH has made comments about AvL's Application and products on the public record, AvL feels compelled to provide the following rebuttal to insure a correct public record.

As detailed below, the AvL Models 750, 960 and 1000 will not cause unacceptable levels of interference under conditions of uniform 2° satellite orbital spacings, will not create a radiation hazard, and will not be operated so that the elevation pattern is ever aligned with the orbital arc. The AvL Roto-Lok® Drive with TracStar Auto-acquisition Controller has been demonstrated and proven by the major satellite operators to perform precise beam center alignment (very important for less than 1.2M aperture) to the correct satellite and consistently better alignment than human technicians. AvL believes that, like many other automation applications, alignment of the beam of a small parabolic antenna can be performed by computer control consistently better than human control. One major advantage is that computers will only perform as programmed and do not vary depending on operator, training, skills or operator haste or financial interest. This performance has been demonstrated to PanAmSat, who originally opposed AvL's original application, which resulted in them signing the affidavit attached to the re-submittal for the Models 750, 960 and 1000. Furthermore, contrary to SWE-DISH's belief, the TracStar controller is not even a satellite tracking system. Indeed, with the beamwidth of these antennas and the satellite station keeping accuracy there is no requirement for auto-tracking.

SWE-DISH's comments also imply, without any support, that single-offset antennas are inferior to dual-offset antennas, suggesting that the back radiation control of the dual-offset antenna is a major advantage. Wholly apart from the fact that this is no basis to oppose the AvL application, AvL's technical staff has been developing and testing dual-offset antennas since 1979, and AvL's technical staff believes the advantages of single-offset antennas for small aperture and especially temporary-fixed applications (flyaways and vehicle mounted) far outweigh any disadvantages. This is the same conclusion as the technical staffs of Vertex/RSI, Advent, ERA Technology, Continental Microwave, Patriot, and others that produce single-offset antennas for similar requirements. SWE-DISH is the only company that selected dual-optics for small aperture, temporary-fixed as a standard product. Dual-optics in small aperture antennas, especially offset, are normally only used where significant off-axis cross-pol improvement is desired. AvL believes FCC requirements are better met with single-offset antennas for small aperture applications, and that the unsupported SWE-DISH views should be seen as nothing more than an unjustified marketing effort.

In general, dual-optics periodically are selected to improve antenna efficiency on large antennas in order to "fold" the optics back so that large, heavy RF equipment can be located in or near the center hub of the antenna. Antenna designers know that this additional optic surface must be precisely aligned with the main optic surface to produce the design performance. Any minor alignment variation of these optical surfaces can cause major change in antenna performance which does not occur from substantial misalignment of feeds in single-offset designs. Hence, single-offset is the preferred configuration for temporary fixed parabolic antennas by all major antenna manufacturers except SWE-DISH. The FCC should take official notice of the large number of its licenses in this regard.

It is ironic that SWE-DISH selected to deal with the sensitivity of dual-optic antennas in their comments but did not note that the main advantage of dual-optic antennas is their reported 72% efficiency, which is substantially more than the 54% of their own design, and their own design is even less than the 62% typical of the usually less efficient single-offset design. The SWE-DISH poor efficiency is probably the result of grossly under illuminating the reflector in order to change their original design which only met 32-25 log Θ to meet the FCC requirements of 29-25 log Θ. This may explain the 1.3 dB lower gain figure in the FCC application than they previously published. It also undercuts any argument that they might make against the AvL antenna.

The back radiation of the AvL products Model 750, 960 and 1000 is consistent with FCC §25.209 requirements and similar to almost all antennas previously approved by the FCC. SWE-DISH suggests that for single-offset antennas the dish must be or is uniformly illuminated. This, they contend, will result in a backlobe of a level consistent with the antenna surface power density and is the reason for their perceived unacceptable backlobe radiation hazard. This is simply incorrect. First, the pattern data submitted is far-field data and not near-field, which is applicable to radiation levels near the reflector including behind the reflector. U.S. satellite industry standards, that have been confirmed with actual test data, is the energy level at the edge of the reflector in the near-field is best calculated by taking the feed input power divided by the reflector surface area. It has also been found that these energy levels are the same for highly shaped dual reflector antennas. The reason is understood when you understand the vast difference of far-field measurements versus near-field.

The unsupported statement SWE-DISH made that AvL uniformly illuminates the reflector also is not technically correct. The pattern from the corrugated horn feed produces a tear-drop radiation pattern at the reflector surface that falls off toward the edge by about 10 dB. The far-field reflector spillover energy seen from 120° to 180° in the AvL patterns is quite common for efficiently designed antennas and can be found on almost every antenna the FCC has authorized. That is one reason the FCC has recommended in FCC IB Docket 00-248 that the back radiation limit be raised to 0 dBi for Ku-Band antennas to adjust the standards to match properly designed and widely licensed antennas. Grossly under-illuminating an antenna to improve back radiation is a poor utilization of resources, especially when the real benefit is only realized in the far-field. It is much more prudent to use energy absorbing material around the edge of the reflector than to extend an accurate optical surface just to block energy.

The 20 dBi spike on the Model 1000 iSNG test data is clearly due to range reflections. Attached is the wide angle test data run on the antenna test range at Georgia Tech Research Institute showing the absence of this test range reflection.

The attached expanded Radiation Hazard analysis confirms that the back radiation of the AvL products do not produce a Radiation Hazard. Note that all antennas licensed by the FCC will have back radiation energy levels based on power input into feed and surface area of reflector.

The patterns submitted were supplemental information for the demonstration of the non-interference analysis. Additional pattern data on these antennas are on file at the FCC and can be supplied by AvL if requested by the FCC. Note the SWE-DISH's application SES-LIC-20030910-01236 does not include a complete set of range test data.

SWE-DISH indicates that the patterns submitted on the Model 1000 iSNG may have been of a solid reflector and not a cut reflector and should be questioned because they were produced at a TriPoint Global test range. We will let TriPoint Global speak to their credibility. However, attached for the public record is yet another set of test data of a segmented Model 1000 iSNG done in March 2004 at Georgia Tech Research Institute, which is the same test range used by SWE-DISH for performing tests on their antenna. Comparison will show they are almost identical for two different antennas produced at different times.

SWE-DISH raises its concern about the AvL antennas' ability to transmit on both polarizations. They suggest that because the polarization adjustment is accomplished by rotation of the reflector and feed assembly about the boresight that for one of the transmit polarizations this would cause the elevation cut to be aligned with the orbital plane. Again, this is totally incorrect. For the majority of applications, these antennas are operated in fixed networks on the same satellite and transponder (*e.g.*, the same polarization) and the antennas are delivered to a specific customer with the feed (OMT) set to the correct orientation. For those other applications requiring use on multiple satellites and/or transponders the feed is mechanically rotated by 90 degrees to select horizontal or vertical uplink polarization prior to automatic polarization adjustment. Indeed, rotation of the reflector and feed assembly for polarization adjustment always assures that the azimuth cut axis (major axis of the Model 750 elliptical) will be perfectly aligned with the orbital plane.

Again, AvL Technologies is happy to supply any additional information or demonstration that the FCC may desire to show that U.S. manufacturers, such as AvL, have the satellite antenna and equipment expertise to produce smaller than 1.2M aperture antennas that do not cause harmful interference to satellites spaced uniformly at 2°. AvL submits that the authorization of smaller than 1.2M antennas by the FCC is important to promoting commerce for the satellite communication industry. Equally important is restricting smaller than 1.2M aperture antennas that may be sold for other markets and that prevent this from occurring.

Regards,

James L. Oliver
President

cc: Maury J. Mechanick, White & Case, LLP
(Counsel to SWE-DISH Satellite Communications, Inc.)
William K. Coulter, (Counsel to AvL)

RADIATION HAZARD STUDY
For
AvL Technologies Model 750 iMoVSAT

This analysis predicts the radiation levels around a proposed earth station complex, comprised of one or more aperture (reflector) type antennas. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields," Edition 97-01, pp 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a **controlled environment** and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a **uncontrolled environment**. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Actual Diameter		0.75 meters
Antenna Surface Area		0.44 sq. meters
Antenna Isotropic Gain		39.3 dBi
Number of Identical Adjacent Antennas*		0
Nominal Antenna Efficiency (ε)		69%
Nominal Frequency		14125 MHz
Nominal Wavelength (λ)		0.0212 meters
Maximum Transmit Power / Carrier		3.2 Watts
Number of Carriers		1
Total Transmit Power		3.2 Watts
W/G Loss from Transmitter to Feed		0.25 dB
Total Feed Input Power		3.0 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda =$	6.6 Meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda =$	15.9 Meters
Transition Region	R_{nf} to R_{ff}	

*The Radiation Levels will be increased directly by the number of antennas indicated, on the assumption that all antennas may illuminate the same area.

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65. In addition to the input parameters above, input cells are provided below for the user to evaluate the power density at specific distances or angles.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

PD_{refl} = 4P/A = 2.72 mW/cm² (1)

Where: P = total power at feed, milliwatts

A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, i.e., the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\,\varepsilon\,P)/(\pi\,D^2)$ = 1.88 mW/cm² (2)

From 0 to 6.6 meters

Evaluation

Uncontrolled Environment:	Exceeds FCC Limits
Controlled Environment:	Complies with FCC Limits

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

$PD_t = (PD_{nf})(R_{nf})/R$ = dependent on R (3)

where: PD_{nf} = near field power density

R_{nf} = near field distance

R = distance to point of interest

For: $6.6 < R < 15.9$ meters

We use Eq (3) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu}:	12.4
Controlled Environment Safe Operating Distance,(meters), R_{safec}:	0.0

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

$$PD_{ff} = PG/(4 \pi R^2) = \text{dependent on } R \quad (4)$$

where: P = total power at feed

G = Numeric Antenna gain in the direction of interest relative to isotropic radiator

R = distance to the point of interest

For: $R > R_{ff}$ = 15.9 meters

PD_{ff} = 0.8 mW/cm² at R_{ff}

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} :	See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} :	See Section 3

5.0 Off-Axis Levels at the FarField Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$

for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees

(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At one (1) degree off axis At the far-field limit, we can calculate the power density as:

G_{off} = 32 - 25log(1) = 32 - 0 dBi = 1585 numeric

$$PD_{1\ deg\ off\text{-}axis} = PD_{ff} \times 1585/G = 0.15\ mW/cm^2 \quad (5)$$

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$PD_{nf(off\text{-}axis)} = PD_{nf}/100 =$ 0.019 mW/cm^2 at D off axis (6)

See page 5 for the calculation of the distance vs elevation angle required to achieve this rule for a given object height.

7.0 Region Between the Feed Horn and Sub-reflector

Transmissions from the feed horn are directed toward the subreflector surface, and are confined within a conical shape defined by the feed horn. The energy between the feed horn and subreflector is conceded to be in excess of any limits for maximum permissible exposure. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

Note 1:
Mitigation of the radiation level may take several forms. First, check the distance from the antenna to the nearest potentially occupied area that the antenna could be pointed toward, and compare to the distances appearing in Sections 2, 3 & 4. If those distances lie within the potentially hazardous regions, then the most common solution would be to take steps to insure that the antenna(s) are not capable of being pointed at those areas while RF is being transmitted. This may be accomplished by setting the tracking system to not allow the antenna be pointed below certain elevation angles. Other techniques, such as shielding may also be used effectively.

Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

$$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha) \quad (7)$$

Where: α = minimum elevation angle of antenna

D = dish diameter in meters

h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (7), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	0.75	meters
	h =	3	meters
Then:			
	α	**S**	
	5	27.2	meters
	10	13.5	meters
	15	9.0	meters
	20	6.7	meters
	25	5.3	meters
	30	4.3	meters
	45	2.7	meters

Suitable fencing or other barrier should be provided to prevent casual occupancy of the area in front of the antenna within the limits prescribed above at the lowest elevation angle required. In most applications this antenna will be mounted on the roof of a vehicle and therefore will not pose a problem.

RADIATION HAZARD STUDY
For
AvL Technologies Model 960 AvSAT

This analysis predicts the radiation levels around a proposed earth station complex, comprised of one or more aperture (reflector) type antennas. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields," Edition 97-01, pp 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a **controlled environment** and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a **uncontrolled environment**. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Actual Diameter		0.96 meters
Antenna Surface Area		0.72 sq. meters
Antenna Isotropic Gain		41.2 dBi
Number of Identical Adjacent Antennas*		0
Nominal Antenna Efficiency (ε)		65%
Nominal Frequency		14125 MHz
Nominal Wavelength (λ)		0.0212 meters
Maximum Transmit Power / Carrier		12.7 Watts
Number of Carriers		1
Total Transmit Power		12.7 Watts
W/G Loss from Transmitter to Feed		0.5 dB
Total Feed Input Power		11.3 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda =$	10.9 Meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda =$	26.1 Meters
Transition Region	R_{nf} to R_{ff}	

*The Radiation Levels will be increased directly by the number of antennas indicated, on the assumption that all antennas may illuminate the same area.

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65. In addition to the input parameters above, input cells are provided below for the user to evaluate the power density at specific distances or angles.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

PD_{refl} = 4P/A = 6.24 mW/cm² (1)

Where: P = total power at feed, milliwatts
A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, i.e., the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\ \varepsilon\ P)/(\pi\ D^2)$ = 4.08 mW/cm² (2)

From 0 to 10.9 meters

Evaluation

Uncontrolled Environment:	Exceeds FCC Limits
Controlled Environment:	Complies with FCC Limits

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

$PD_t = (PD_{nf})(R_{nf})/R$ = dependent on R (3)

where: PD_{nf} = near field power density
R_{nf} = near field distance
R = distance to point of interest
For: $10.9 < R < 26.1$ meters

We use Eq (3) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu}:	34.5
Controlled Environment Safe Operating Distance,(meters), R_{safec}:	<10.9

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

PD_{ff} = $PG/(4 \pi R^2)$ = dependent on R (4)

where: P = total power at feed

G = Numeric Antenna gain in the direction of interest relative to isotropic radiator

R = distance to the point of interest

For: $R > R_{ff}$ = 26.3 meters

PD_{ff} = 1.75 mW/cm² at R_{ff}

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} :	See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} :	See Section 3

5.0 Off-Axis Levels at the FarField Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$

for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees

(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At one (1) degree off axis At the far-field limit, we can calculate the power density as:

G_{off} = 32 - 25log(1) = 32 - 0 dBi = 1585 numeric

$$PD_{1\ deg\ off\text{-}axis} = PD_{ff} \times 1585/G = 0.21\ mW/cm^2 \quad (5)$$

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$$PD_{nf(off\text{-}axis)} = PD_{nf}/100 = 0.041\ mW/cm^2 \text{ at D off axis} \quad (6)$$

See page 5 for the calculation of the distance vs elevation angle required to achieve this rule for a given object height.

7.0 Region Between the Feed Horn and Sub-reflector

Transmissions from the feed horn are directed toward the subreflector surface, and are confined within a conical shape defined by the feed horn. The energy between the feed horn and subreflector is conceded to be in excess of any limits for maximum permissible exposure. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

Note 1:
Mitigation of the radiation level may take several forms. First, check the distance from the antenna to the nearest potentially occupied area that the antenna could be pointed toward, and compare to the distances appearing in Sections 2, 3 & 4. If those distances lie within the potentially hazardous regions, then the most common solution would be to take steps to insure that the antenna(s) are not capable of being pointed at those areas while RF is being transmitted. This may be accomplished by setting the tracking system to not allow the antenna be pointed below certain elevation angles. Other techniques, such as shielding may also be used effectively.

Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

$$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha) \quad (7)$$

Where: α = minimum elevation angle of antenna
D = dish diameter in meters
h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (7), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	0.96	meters
	h =	3	meters
Then:			
	α	**S**	
	5	28.4	meters
	10	14.1	meters
	15	9.4	meters
	20	7.0	meters
	25	5.5	meters
	30	4.6	meters
	45	2.9	meters

Suitable fencing or other barrier should be provided to prevent casual occupancy of the area in front of the antenna within the limits prescribed above at the lowest elevation angle required.

RADIATION HAZARD STUDY
For
AvL Technologies Model 1000 iSNG

This analysis predicts the radiation levels around a proposed earth station complex, comprised of one or more aperture (reflector) type antennas. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields," Edition 97-01, pp 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a **controlled environment** and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a **uncontrolled environment**. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Actual Diameter		1.0 meters
Antenna Surface Area		0.79 sq. meters
Antenna Isotropic Gain		41.5 dBi
Number of Identical Adjacent Antennas*		0
Nominal Antenna Efficiency (ε)		65%
Nominal Frequency		14125 MHz
Nominal Wavelength (λ)		0.0212 meters
Maximum Transmit Power / Carrier		19.9 Watts
Number of Carriers		1
Total Transmit Power		19.9 Watts
W/G Loss from Transmitter to Feed		0.5 dB
Total Feed Input Power		17.7 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda =$	11.8 Meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda =$	28.3 Meters
Transition Region	R_{nf} to R_{ff}	

*The Radiation Levels will be increased directly by the number of antennas indicated, on the assumption that all antennas may illuminate the same area.

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65. In addition to the input parameters above, input cells are provided below for the user to evaluate the power density at specific distances or angles.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

PD_{refl} = 4P/A = 9.01 mW/cm² (1)

Where: P = total power at feed, milliwatts

A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, i.e., the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\, \varepsilon\, P)/(\pi\, D^2) =$ 5.81 mW/cm² (2)

From 0 to 11.8 meters

Evaluation

Uncontrolled Environment:	Exceeds FCC Limits
Controlled Environment:	Exceeds FCC Limits

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

PD_t = $(PD_{nf})(R_{nf})/R$ = dependent on R (3)

where: PD_{nf} = near field power density

R_{nf} = near field distance

R = distance to point of interest

For: 11.8 < R < 28.3 meters

We use Eq (3) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu}:	44.5
Controlled Environment Safe Operating Distance,(meters), R_{safec}:	13.7

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

$$PD_{ff} = PG/(4 \pi R^2) = \text{dependent on } R \qquad (4)$$

where: P = total power at feed

G = Numeric Antenna gain in the direction of interest relative to isotropic radiator

R = distance to the point of interest

For: $R > R_{ff}$ = 28.3 meters

PD_{ff} = 2.49 mW/cm^2 at R_{ff}

We use Eq (4) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation:

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} :	See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} :	See Section 3

5.0 Off-Axis Levels at the FarField Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$

for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees

(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At one (1) degree off axis At the far-field limit, we can calculate the power density as:

$$G_{off} = 32 - 25\log(1) = 32 - 0 \text{ dBi} = 1585 \text{ numeric}$$

$$PD_{1\ deg\ off\text{-}axis} = PD_{ff} \times 1585/G = 0.279 \text{ mW/cm}^2 \quad (5)$$

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$PD_{nf(off\text{-}axis)} = PD_{nf}/100 =$ 0.058 mW/cm^2 at D off axis (6)

See page 5 for the calculation of the distance vs elevation angle required to achieve this rule for a given object height.

7.0 Region Between the Feed Horn and Sub-reflector

Transmissions from the feed horn are directed toward the subreflector surface, and are confined within a conical shape defined by the feed horn. The energy between the feed horn and subreflector is conceded to be in excess of any limits for maximum permissible exposure. This area will not be accessible to the general public. Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

Note 1:
Mitigation of the radiation level may take several forms. First, check the distance from the antenna to the nearest potentially occupied area that the antenna could be pointed toward, and compare to the distances appearing in Sections 2, 3 & 4. If those distances lie within the potentially hazardous regions, then the most common solution would be to take steps to insure that the antenna(s) are not capable of being pointed at those areas while RF is being transmitted. This may be accomplished by setting the tracking system to not allow the antenna be pointed below certain elevation angles. Other techniques, such as shielding may also be used effectively.

Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

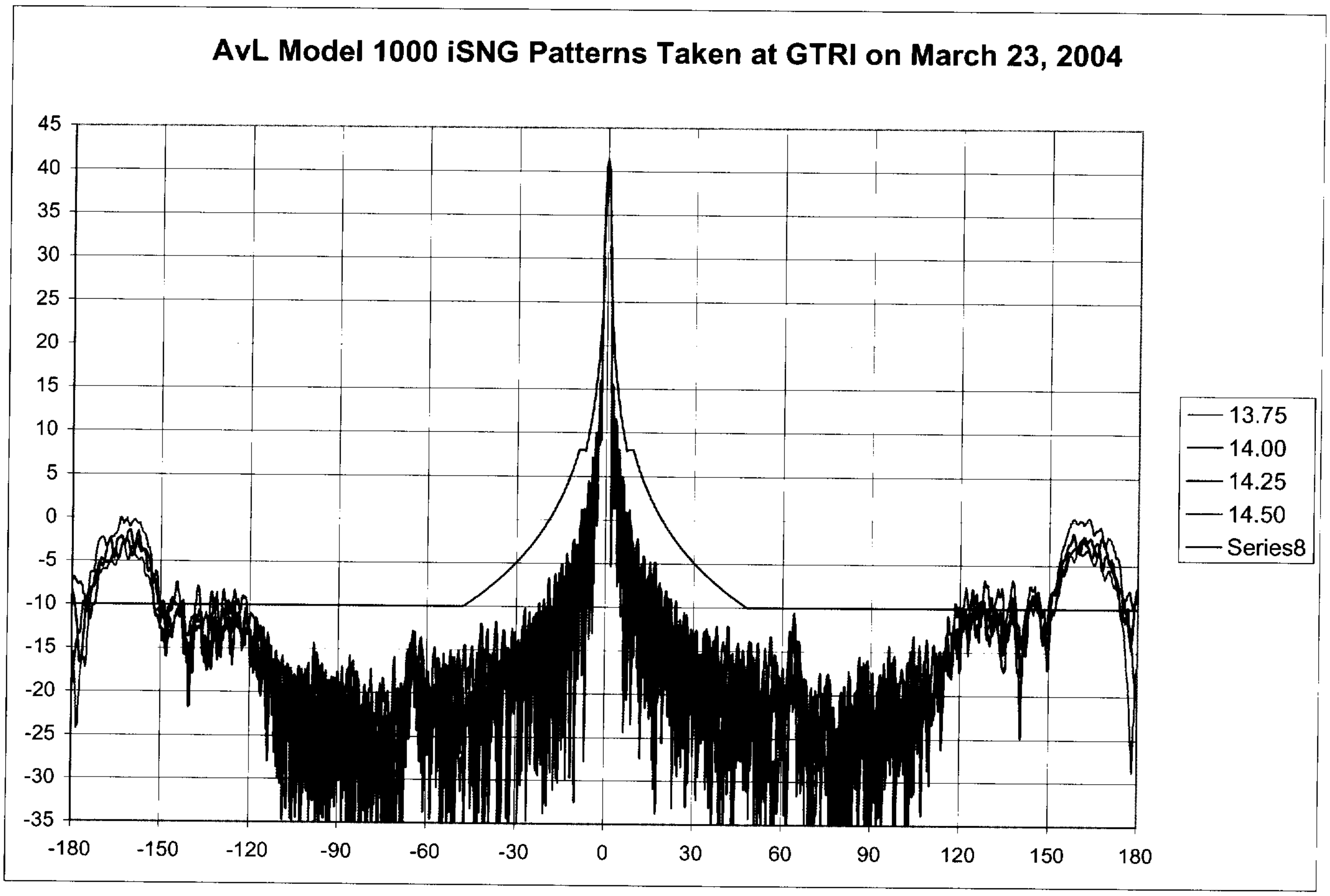
$$S = (D/ \sin \alpha) + (2h - D - 2)/(2 \tan \alpha) \quad (7)$$

Where: α = minimum elevation angle of antenna
D = dish diameter in meters
h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (7), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	1.0	meters
	h =	3	meters
Then:			
	α	**S**	
	5	28.6	meters
	10	14.3	meters
	15	9.5	meters
	20	7.0	meters
	25	5.6	meters
	30	4.6	meters
	45	2.9	meters

Suitable fencing or other barrier should be provided to prevent casual occupancy of the area in front of the antenna within the limits prescribed above at the lowest elevation angle required.


AvL Model 1000 iSNG Patterns Taken at GTRI on March 23, 2004
45
40
35
30
25
20
15
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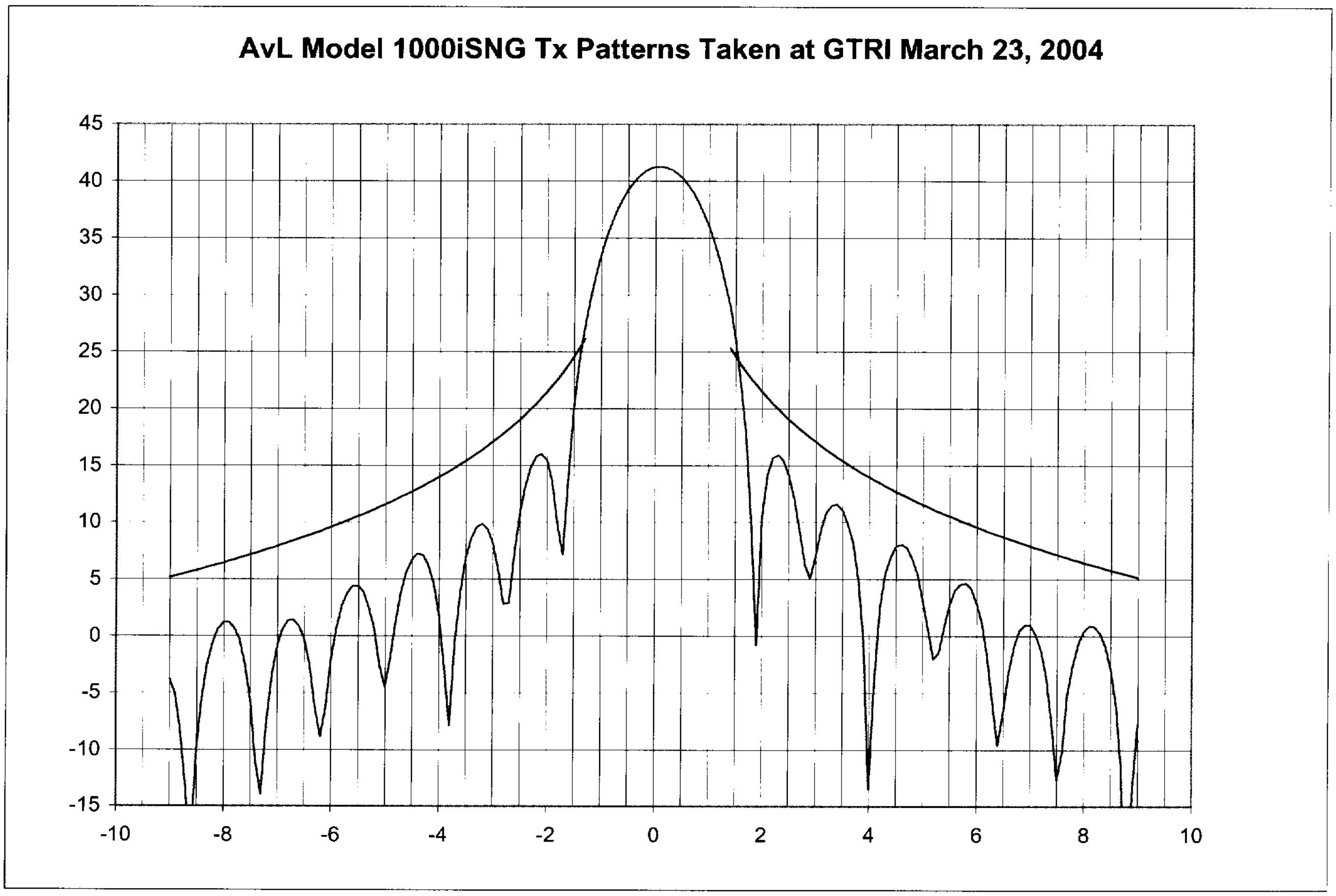
5
0
-5
-10
-15
-20
-25
-30
-35
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180
13.75
14.00
14.25
14.50
Series8


AvL Model 1000iSNG Tx Patterns Taken at GTRI March 23, 2004
45
40
35
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5
0
-5
-10
-15
-10
-8
-6
-4
-2
0
2
4
6
8
10

CERTIFICATE OF SERVICE

I, Christine L. Zepka, hereby certify that on this 20th day of May 2004, a true and correct copy of the foregoing "AvL Technologies Opposition to Petition to Deny" was sent via first class mail to the following parties:

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