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February 21, 2000

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Magalie Roman Salas, Secretary  
Federal Communications Commission  
445 12th Street, S.W.  
Washington, DC 20554

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FEDERAL COMMUNICATIONS COMMISSION

**Re: Permitted Ex Parte Meeting  
The Boeing Company  
ET Docket Nos. 98-206,  
RM-9147, RM-9245**

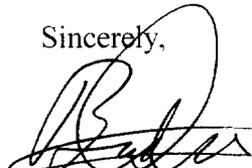
Dear Secretary Salas:

On Friday, February 18, 2000, representatives of The Boeing Company ("Boeing") met with Bruce A. Franca, Deputy Chief, Office of Engineering and Technology, Bruno Pattan, Technical Analysis Branch and Rodney Small, Spectrum Policy Branch. Attending for Boeing was Robert Higgins, along with Mel Barmat of Jansky/Barmat Telecommunications, David A. Nall and Bruce Olcott of Squire, Sanders & Dempsey. Later in the day, Messrs. Higgins and Barmat also met with Harry Ng, Engineering Advisor, Satellite and Radiocommunication Division.

The meetings were held to discuss the contents of Boeing's written *ex parte* presentation in the same proceedings, filed February 16, 2000. The attached presentation was distributed.

Thank you for your attention to this matter. Please contact the undersigned if you have any questions.

Sincerely,



Bruce A. Olcott

Cc: Bruce A. Franca, Deputy Chief, Office of Engineering and Technology  
Bruno Pattan, Technical Analysis Branch  
Rodney Small, Spectrum Policy Branch  
Harry Ng, Engineering Advisor, Satellite and Radiocommunication Division

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# Northpoint Interference into Boeing NGSO System Receivers

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# Sources of Interference to Boeing



- BSS
  - Interference varies as a function of separation angle from GSO arc.
- Other NGSO
  - Interference criteria ITU-R Rec. S.1323
  - 10 % increased unavailability
- Northpoint
  - Interference varies inversely with distance from Northpoint transmitter
  - Exclusion zone for NGSO operations created

# Exclusion Zone



- An exclusion zone exists near a Northpoint transmitter where a Boeing NGSO earth station receiver will receive “unacceptable interference” (defined later).
- Boeing will be unable to mitigate interference and serve customers inside the Northpoint exclusion zones.

# Interference Criteria



- Appropriate Interference Criteria is ITU-R Recommendation S.1323 with draft revisions from May 1999
  - Applicable to systems where relative motion of interfering sources is involved
  - Increase in system unavailability of  $< 10\%$  due to all interfering sources
- Inappropriate Criteria used by Northpoint is  $I_o/N_o = 0$  dB
  - Would result in outages to all Boeing earth stations within the exclusion zone

# Unavailability



- Primary unavailability due to rain outage
- Rain outage is a function of elevation angle
  - Elevation angle of NGSO earth station antenna varies

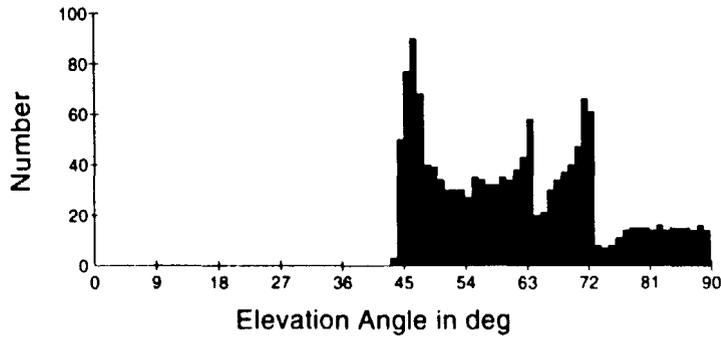
$$p_{rain}(\text{deg } r) = \int_{elv} p_{rain}(\text{deg } r | \theta) \cdot p(\theta) d\theta$$

where  $\text{degr}$  is the signal degradation,  
 $q$  is the elevation angle, and  
 $p()$  is the Probability Density Function (PDF) that the  
signal degradation due to rain will be at a given level.

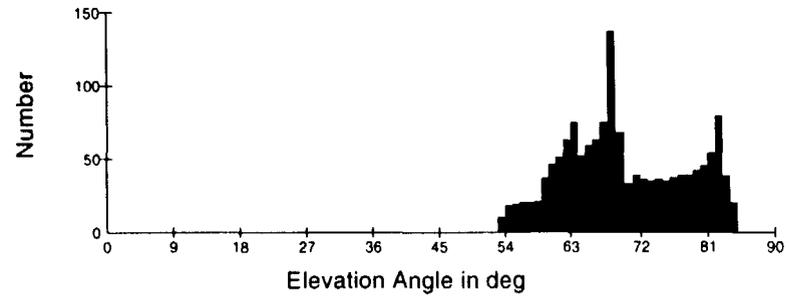
# PDF of Elevation Angle



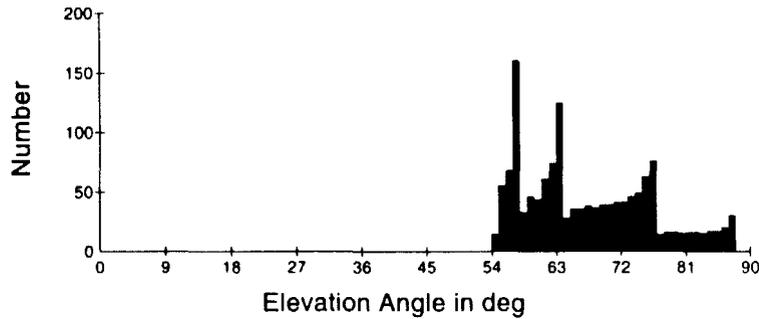
NGSO ES at 20 deg latitude



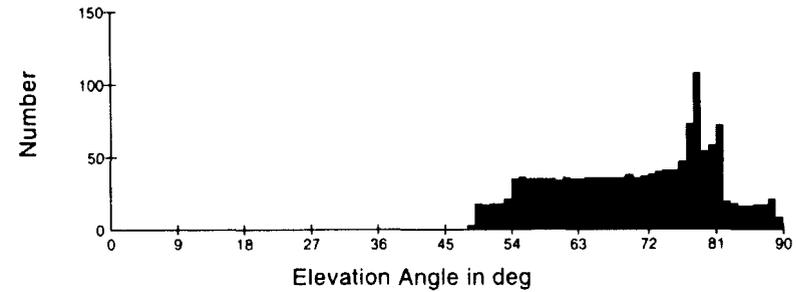
NGSO ES at 40 deg Latitude



NGSO ES at 30 deg Latitude



NGSO ES at 50 deg Latitude



# Boeing System Margin Requirement



Rain Zone K

Circular polarization

Altitude = 0.0

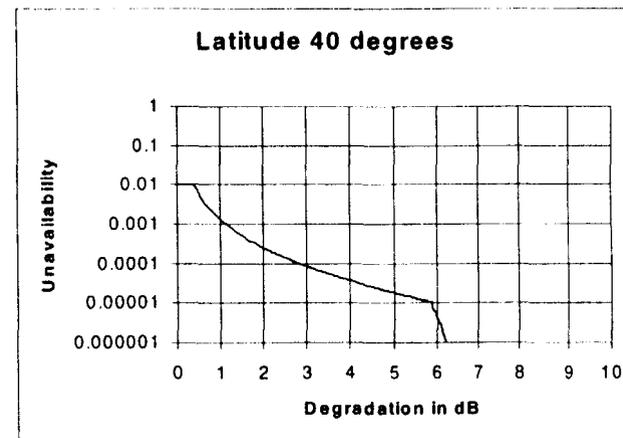
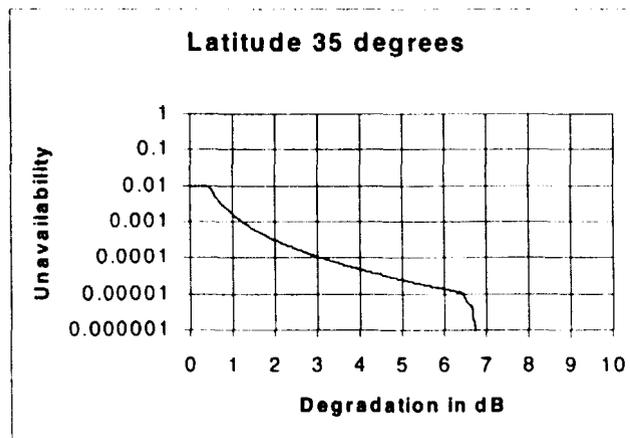
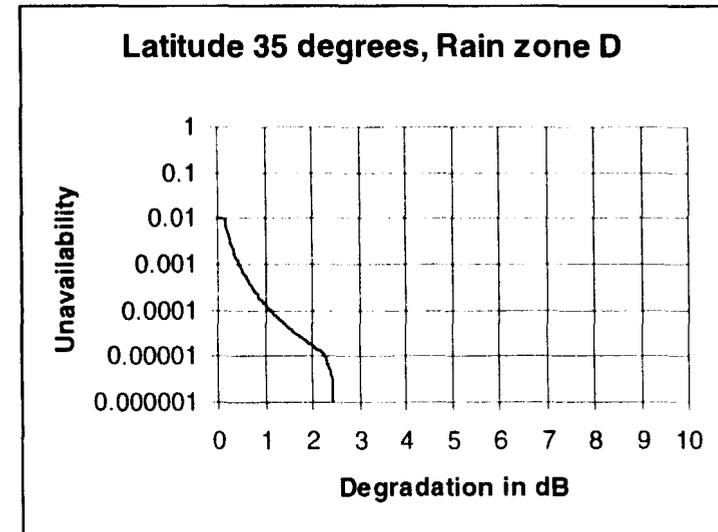
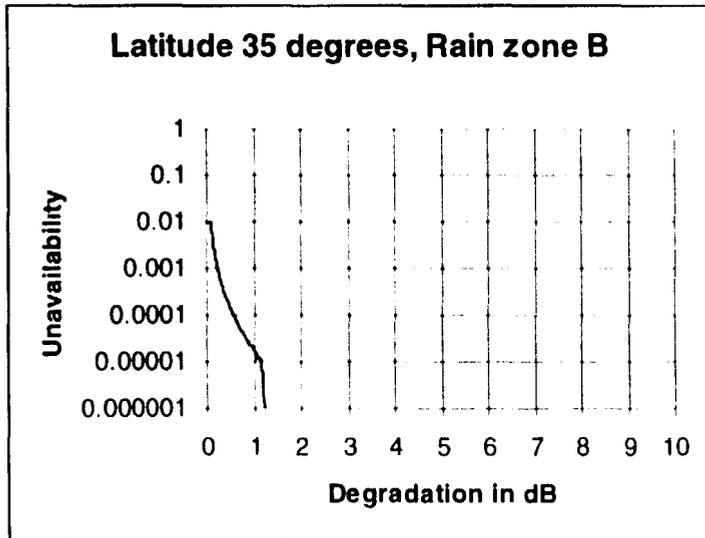


Chart 7

# Margin for Other Rain Zones



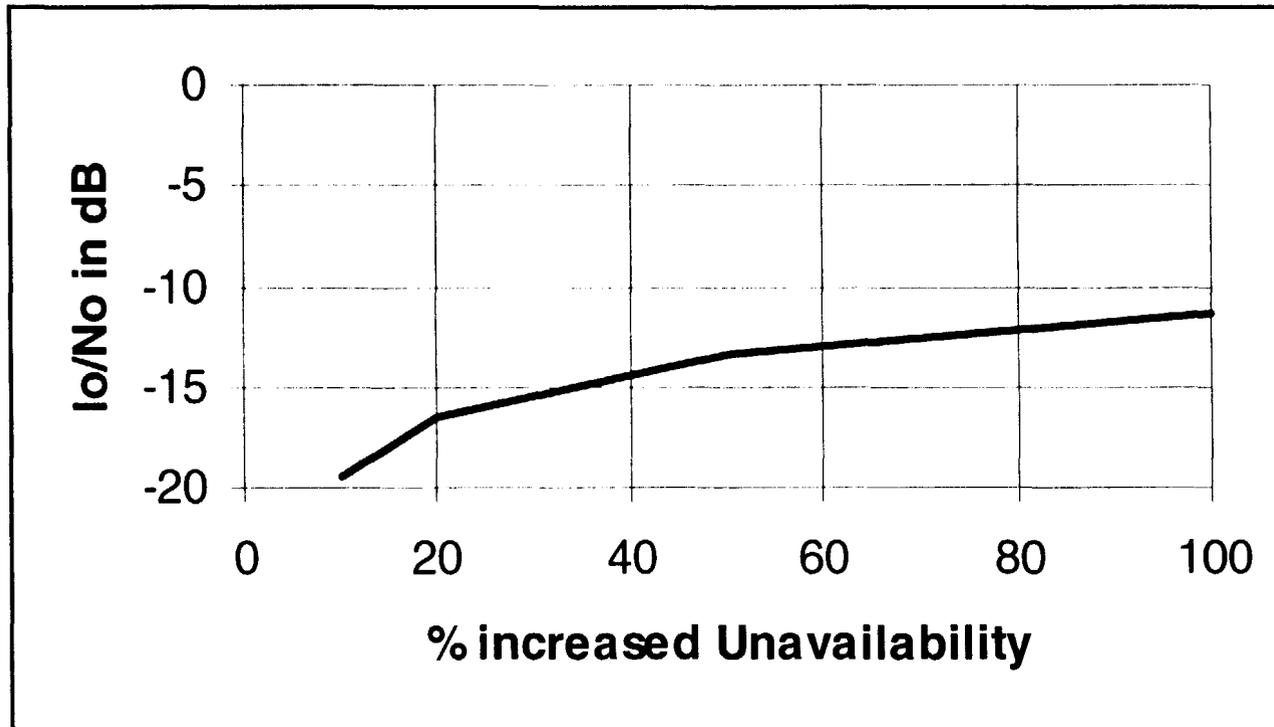
Increased unavailability in lower rain zones would require even lower  $I_o/N_o$  to meet given criteria

Zone K, 10 % increased unavailability:  $I_o/N_o = -19.4$  dB

Zone D, 10 % increased unavailability:  $I_o/N_o = -24.0$  dB

Zone B, 10 % increased unavailability:  $I_o/N_o = -26.9$  dB

# Io/No vs Unavailability



- Boeing system unavailability = 0.1 %
- Assumes constant interference source
- Rain zone K

# Interference Scenario

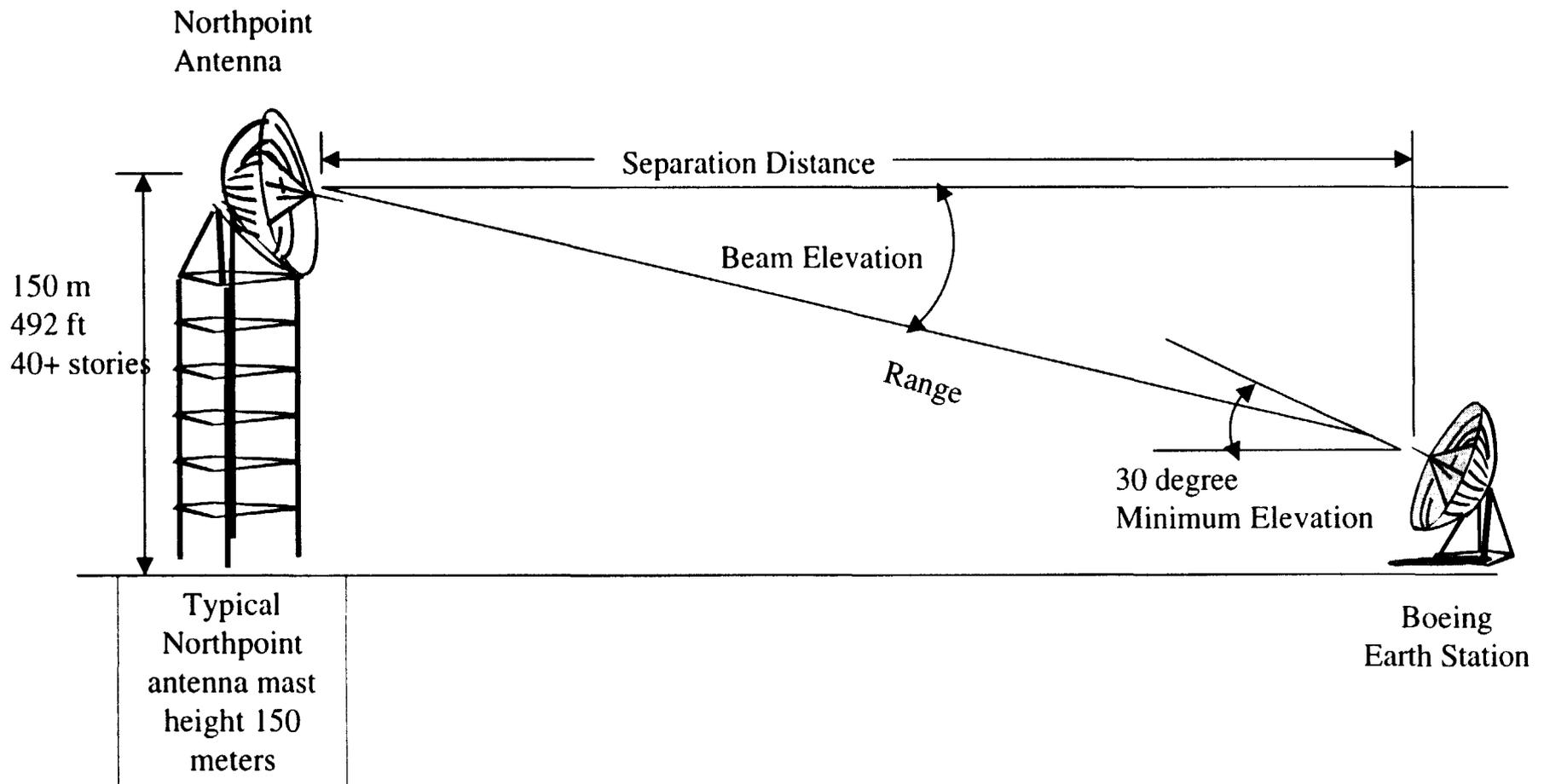


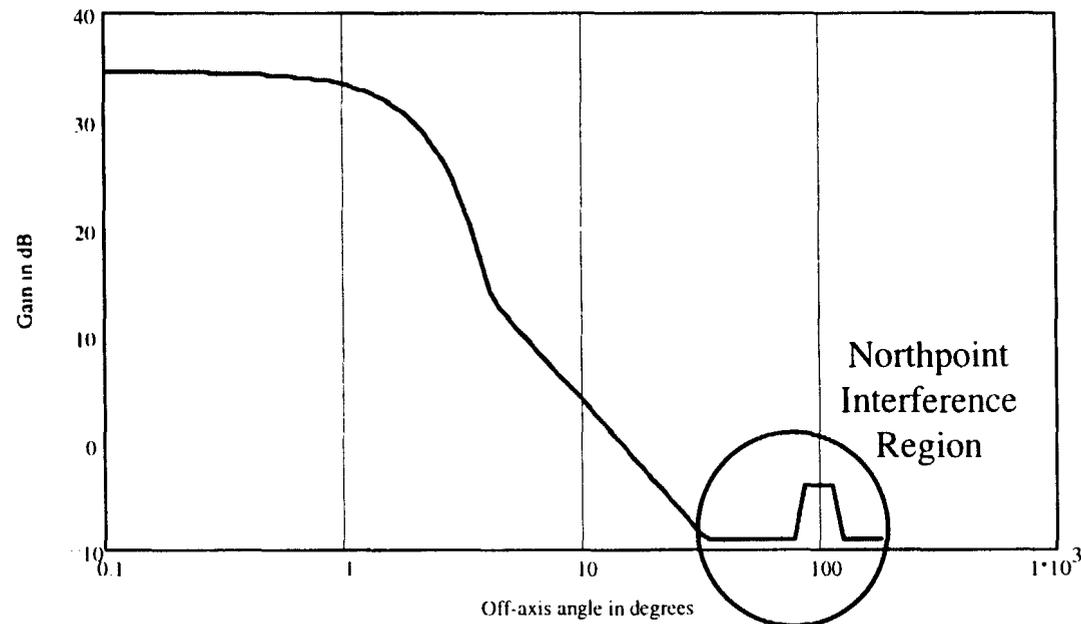
Chart 10

# Boeing Receive Characteristics



- Minimum elevation angle of 30 degrees
- Receive noise temperature of 230° k
- Noise power density of -205 dBW/Hz
- Antenna gain in direction of interference of - 9 dBi

# Receive Antenna Reference Pattern



- Antenna gain flat after 30 degrees off-axis
- Reference pattern is ITU-R Recommendation S.[4/57] (developed for systems with relative motion between interference source and receiver)

# Northpoint

## Transmit Characteristics

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- EIRP of -17.5 dBW
- Peak antenna gain of 10 dB
- Bandwidth of 24 MHz
- EIRP density of -91.3 dBW/Hz

# Interference, Nominal Power



- Determines separation distance required
- 10 % increased unavailability criteria (Rain zone K)

<b>Transmit EIRP</b>	<b>-17.50 dBW</b>
Transmit Bandwidth	24.00 MHz
Transmit EIRP Density	-91.30 dBW/Hz
Receive antenna gain to Northpoi	-9.00 dB
Receive Noise Temperature	230.00 k
Receive Noise Density	-204.98 dBW/Hz
Io/No Required	-19.40 dB
Pathloss Required	124.08 dB
Frequency	12.50 GHz
<b>Separation Required</b>	<b>3.06 km</b>

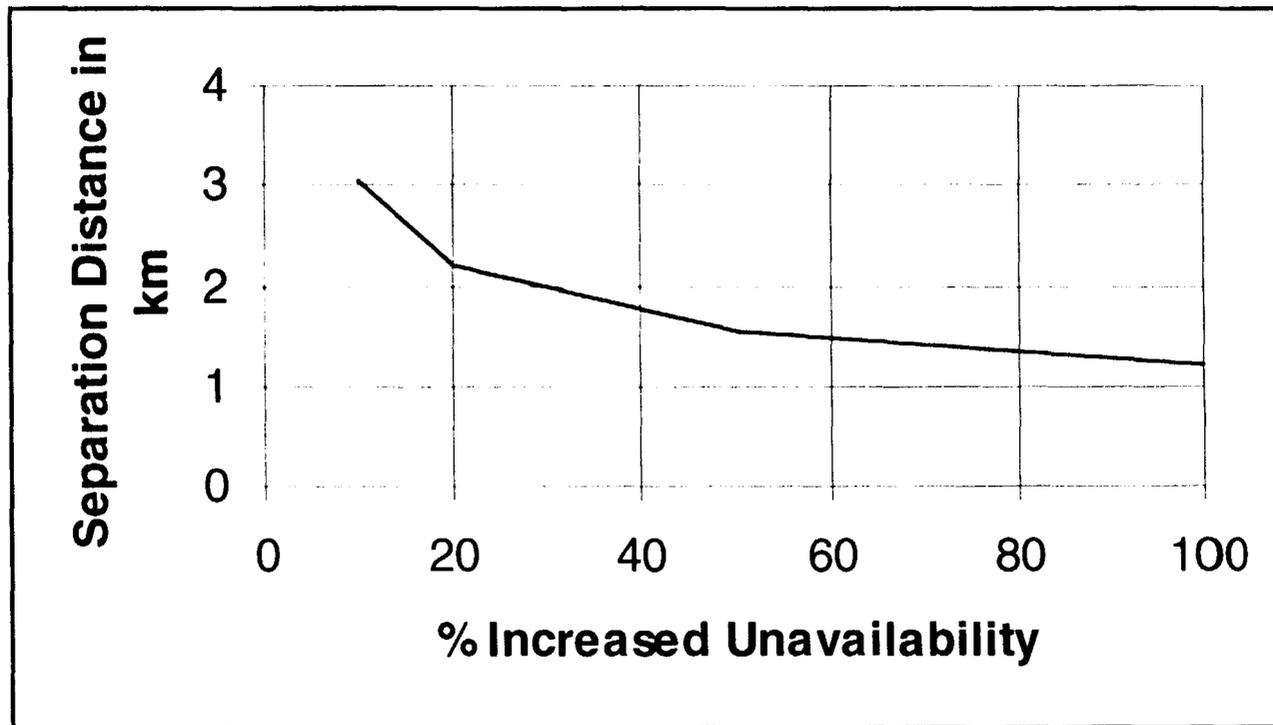
# Interference, Maximum Power



- Determines separation distance required
- 10 % increased unavailability criteria (Rain zone K)

<b>Transmit EIRP</b>	<b>15.00 dBW</b>
Transmit Bandwidth	24.00 MHz
Transmit EIRP Density	-58.80 dBW/Hz
Receive antenna gain to Northpoi	-9.00 dB
Receive Noise Temperature	230.00 k
Receive Noise Density	-204.98 dBW/Hz
Io/No Required	-19.40 dB
Pathloss Required	156.58 dB
Frequency	12.50 GHz
<b>Separation Required</b>	<b>128.86 km</b>

# Separation vs. Increased Unavailability



Rain zone K

# Exclusion Zone



Chart 17

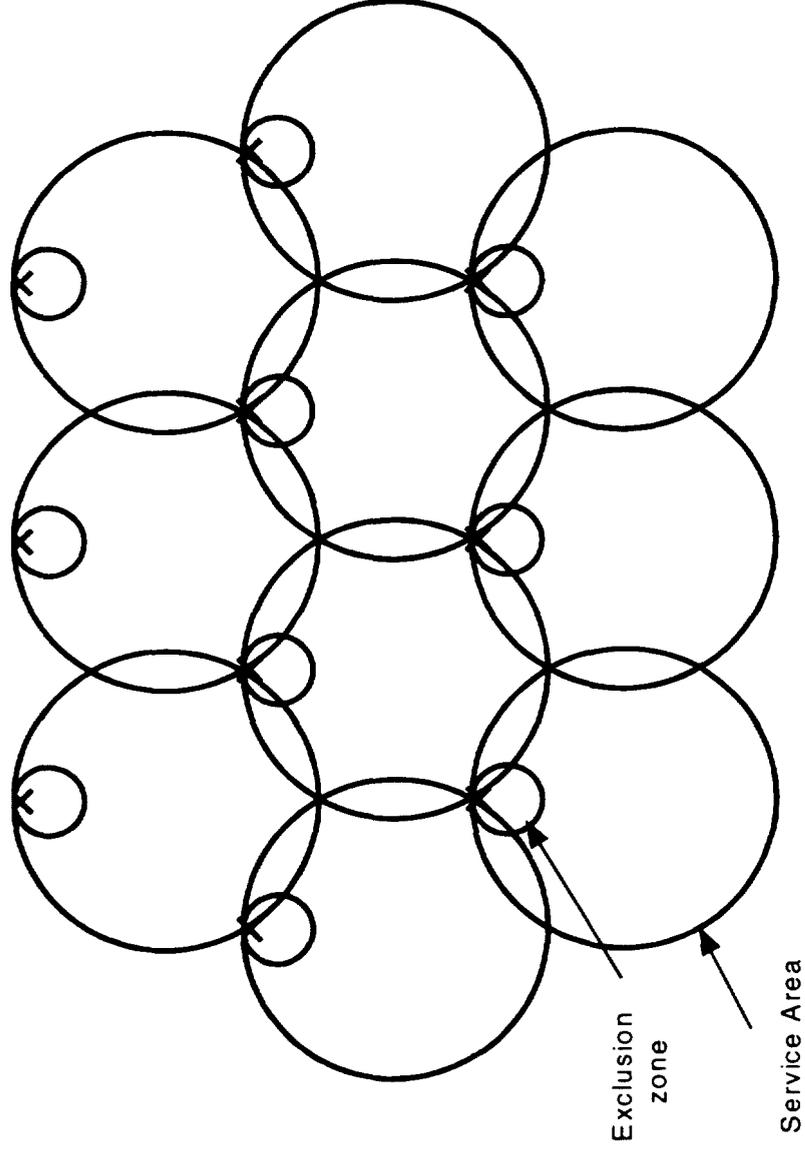
# Northpoint Repeaters



- Northpoint plans to use repeaters to provide service to large metropolitan areas.
- No information provided on repeater density
- No information provided on compensating for terrain conditions

# Assumed (Best Case)

## Grid Layout for Repeaters



# Repeater Interference



- Multiple repeaters operating at same frequency will increase total noise to NGSO earth station receivers
- Northpoint repeater density most likely will be higher than optimal to accommodate terrain conditions.

# Northpoint Needs More Power for Rain Outage



- Northpoint unavailability is 0.3 % annual
  - Degradation allowance of 6.6 dB in rain zone N with 38 dBi receive antenna.
- Broadcast services (BSS) use percent unavailability of worst month.
  - Degradation increased to 12.3 dB in rain zone N with 38 dBi receive antenna
- To compensate, Northpoint must power, which increases exclusion zone area by 3.75

# Interference Mitigation



- Satellite diversity
- Shielding
  - Natural
  - Artificial
- Natural shielding plus satellite diversity
- Frequency diversity (Band Segmentation?)

# Satellite Diversity



- Doesn't Work for interference mitigation inside exclusion zone
- Northpoint transmitter always in far sidelobes of antenna pattern
- Northpoint interference almost constant regardless of earth station pointing

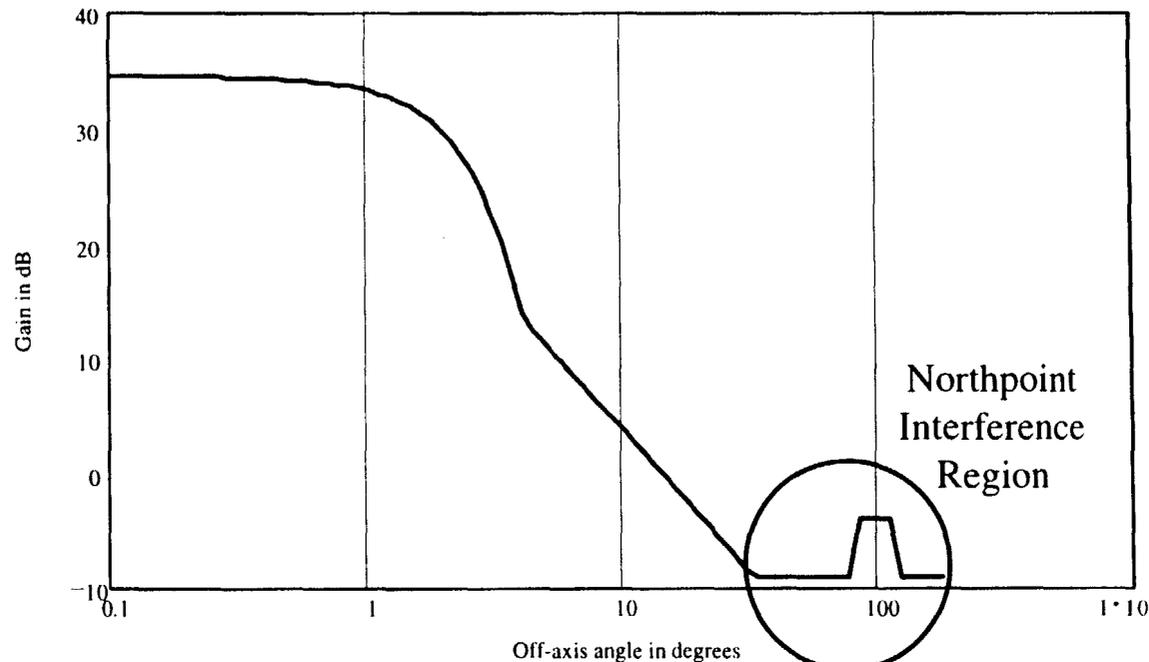


Chart 23

# Natural Shielding



- Boeing NGSO earth station antenna operates down to 30 degree elevation in all directions
- Not likely to find natural environment that will provide appropriate access to satellite assets and still provides shielding from Northpoint transmitters

# Artificial Shielding Required Attenuation

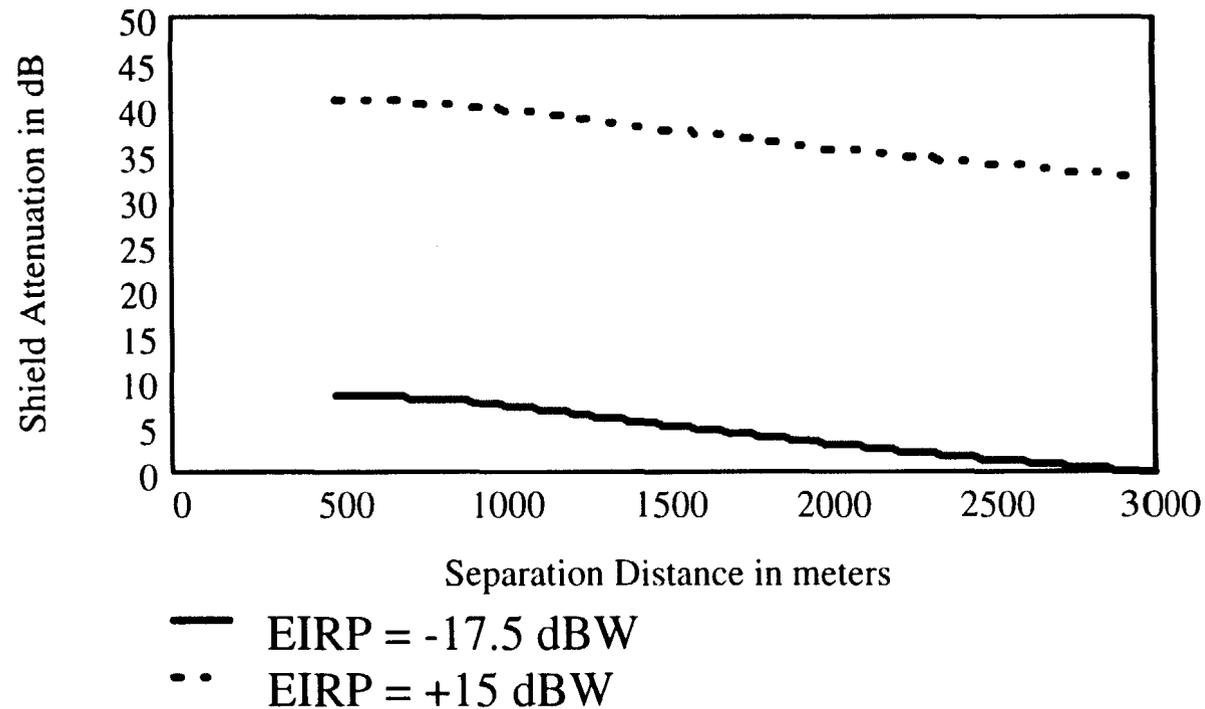


Chart 25

# Artificial Shielding Size: Two Approaches

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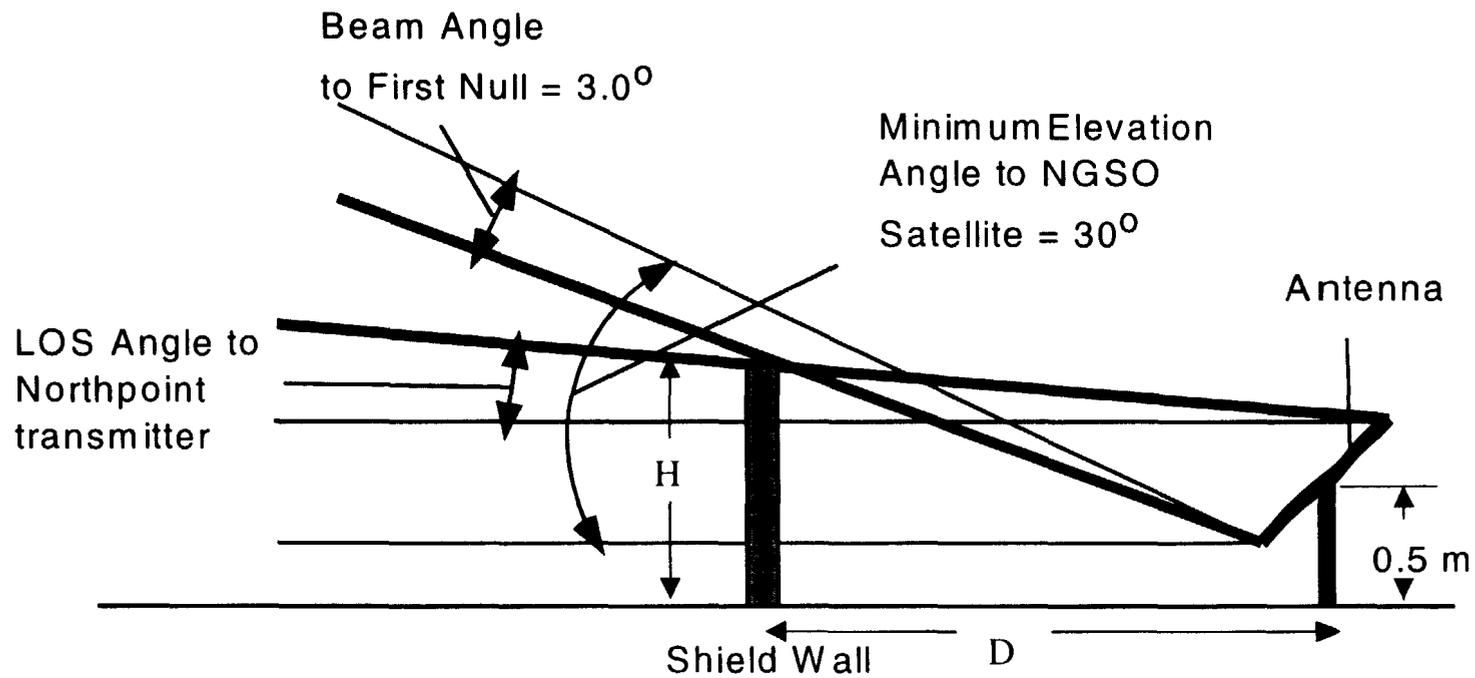


- Minimum geometry approach
  - Shield in near field of antenna results in distortion of pattern
  - increase in sidelobe levels for both receive and transmit
- Near field distance approach
- Proper distance - between two approaches

# Artificial Shielding Geometry



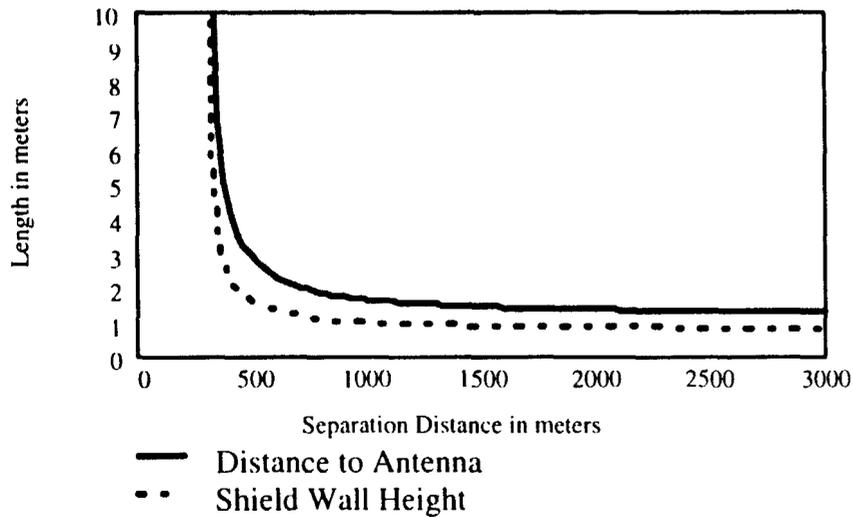
Determination of distance to shield and height of shield



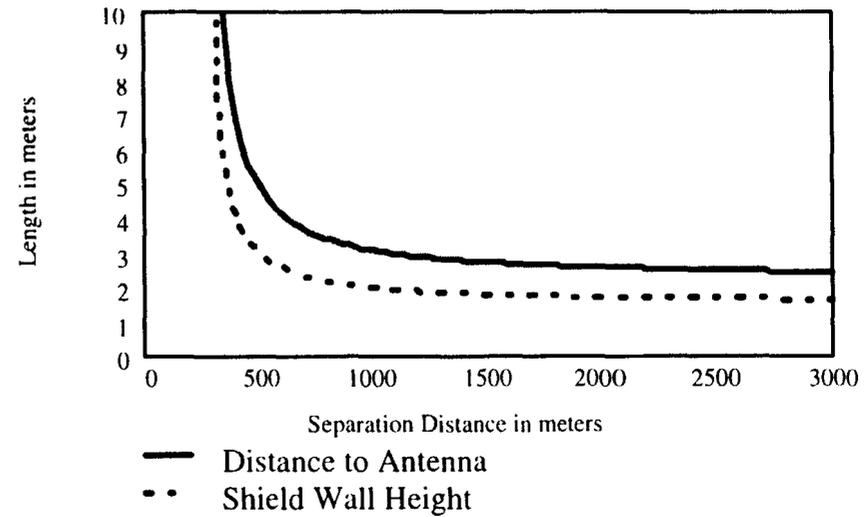
# Artificial Shielding Size, Geometry



### IDS Antenna, 60 cm



### BDS Antenna, 1.2 m



# Artificial Shielding, Near field



IDS antenna near field distance = 15 meters

BDS antenna near field distance = 60 meters

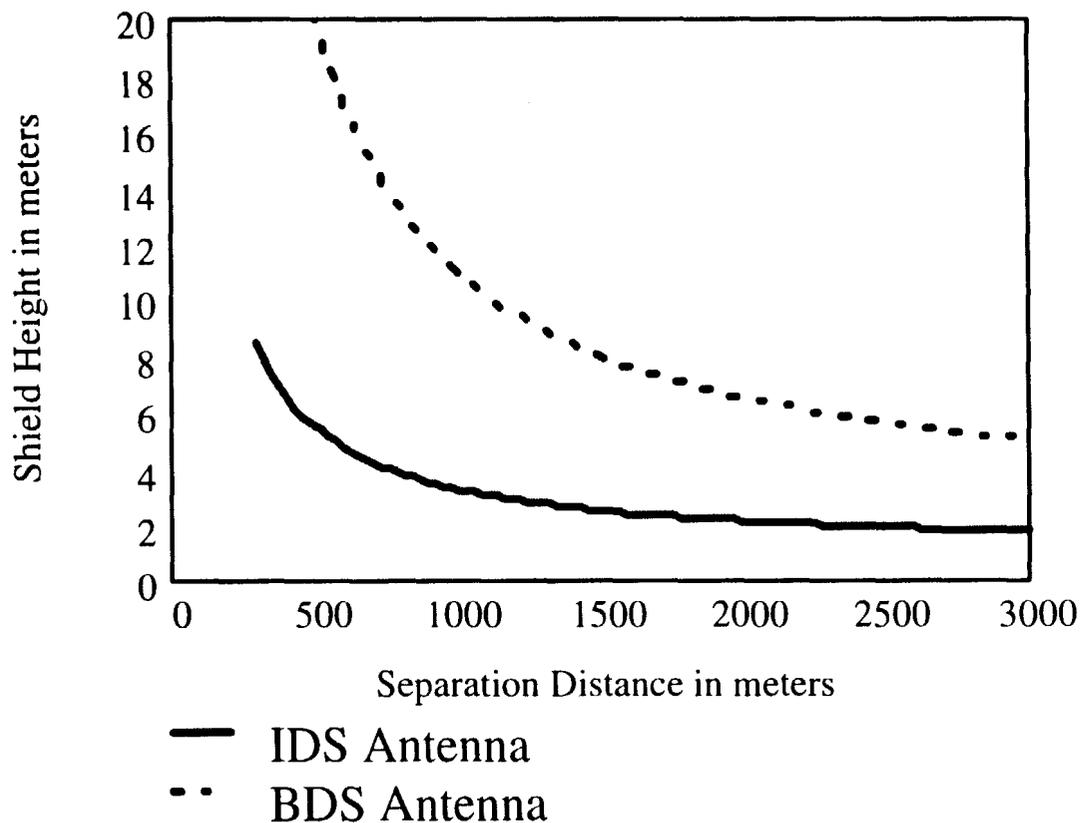


Chart 29

# Natural Shielding + Satellite Diversity



- Boeing system does not provide multiple spot beams covering a given area.
  - Increased EPFD in coverage area increasing interference to GSO earth stations
- Would require serving area only from South
  - Not sufficient space assets to not use North satellites (Impossible for Teledesic Ku-application)
  - Increases EPFD, possibly exceeding limits

# Frequency Diversity



- NGSO users in exclusion zone would not be able to use same frequency band as used by Northpoint
- Boeing has only two frequency bands in each beam, and large spot beams ~1800 km dia.
- Frequency diversity effectively reduces Boeing system capacity in exclusion zone by 1/2
- Much of Boeing transmission is smart-push type data

# NGSO Interference to Northpoint



- Boeing supports ITU-R study results and agreement on PFD limits for sharing with terrestrial systems.
- Boeing system has PFD above  $-158$  dBW/m<sup>2</sup>-4kHz at low elevation angles, but does not cause interference to Northpoint
- Northpoint analysis does not support proposed limits

# Summary



- Interference criteria based on ITU-R Recommendation S.1323

- Exclusion zone (Rain zone K)

Rain zone:	K	D	B
-17.5 dBW EIRP:	3 km	5.7 km	7.1 km
+15 dBW EIRP:	129 km	245 km	306 km

- Repeater architecture, terrain considerations, and rain accommodation will increase relative size of exclusion zones

# Summary, Interference Mitigation



- Satellite diversity does not work
- Natural shielding unlikely
- Artificial shielding adds great cost to Boeing earth station
- Natural shielding with satellite diversity does not work
- “Frequency diversity” is effectively band segmentation, which reduces Boeing capacity to 1/2