EXHIBIT 1 of FCC FORM 422 Question10.

This narrative statement will describe in detail the following:

(a) The complete program of research and experimentation proposed including description of equipment and theory of operation.
(b) The specific objectives to be accomplished
(c) How the program of experimentation has a reasonable promise of contribution to the development extension, expansion or utilization of the radio art, or in along lines not already investigated.

Introduction:

This application builds upon a previous experimental license granted to The Boeing Company, file number 0051-EX-ML-2000, which successfully demonstrated high data rate communications between mobile platforms and Ku-band FSS satellites. This application adds to Boeing's already proven system an improved antenna and improved modem. Mobile platforms in this system will operate in CONUS, Alaska, and Hawaii. The point of communication will be ALSAT Ku. The maximum EIRP of this system will be limited to 43.8 dBW.

Commercial airlines and military services have expressed a desire for two-way data communications while in transit. As a major supplier of aircraft, Boeing is interested in providing this service to its customers. Once developed, the technology would be useful for any mobile platform in need of two-way data communications.

One attractive solution is to provide two-way data service via satellite. Ku-band FSS Satellites provide worldwide terrestrial and limited maritime coverage with sufficient power and bandwidth to enable high rate data communications. Transponders on these satellites may be leased/purchased at a significantly lower cost than the development of a ground-based network or satellites in other bands.

Boeing currently manufactures phased array receive antennas for operation with Ku-band FSS and BSS satellites. This system receives information broadcasts anywhere within CONUS at data rates greater than 5 Mbps. Customers can receive rebroadcast television as well as data transmissions. The low profile array and external mounting hardware virtually eliminate impact to the aerodynamic performance of the platform and all support hardware is installed inside the structure, allowing environmental control and maintenance access.

To satisfy the two-way communication requirement, a return link capability is needed from the platform to the ground station. In order to transmit, the antenna's beam must not interfere with satellites on either side of the target satellite. The FCC threshold for coordination for very small aperture terminals (VSAT) uplinks is defined by an input power of -14 dBW/4 kHz from CFR, title 47, part. 25.134(b) into an antenna gain mask in 25.209. The resulting off-axis EIRP density mask provides a method of determining a level of acceptable interference not requiring coordination. The Boeing experimental system will remain well below this mask by restricting the input power to the antenna.

Objective:

The objective of this experiment is to develop a high data rate, satellite information transmission system to use on mobile platforms. A small aperture Boeing Ku-band phased array antenna will be used to transmit a direct spread spectrum modulated signal. This transmit system will lower the power spectral density to within acceptable interference levels at adjacent satellites.

This mode of operation is essentially the same as used by Boeing's previous experimental license and is similar to the Qualcomm OmniTRACS system that utilizes Ku-band FSS satellites for mobile communications with truck fleets.

Approach:

A simplified block diagram of the proposed experimental system is shown in Figure 1. The mobile platform equipment consists of a spread spectrum modulator, a power amplifier and up converter, 873 element phased array antenna, and system phased array controller (SPAC). The signal from the mobile platform is transponded to the ground station by leased capacity on an Ku-band FSS satellite. The ground station equipment consists of a receive antenna, down converter, and spread spectrum demodulator.

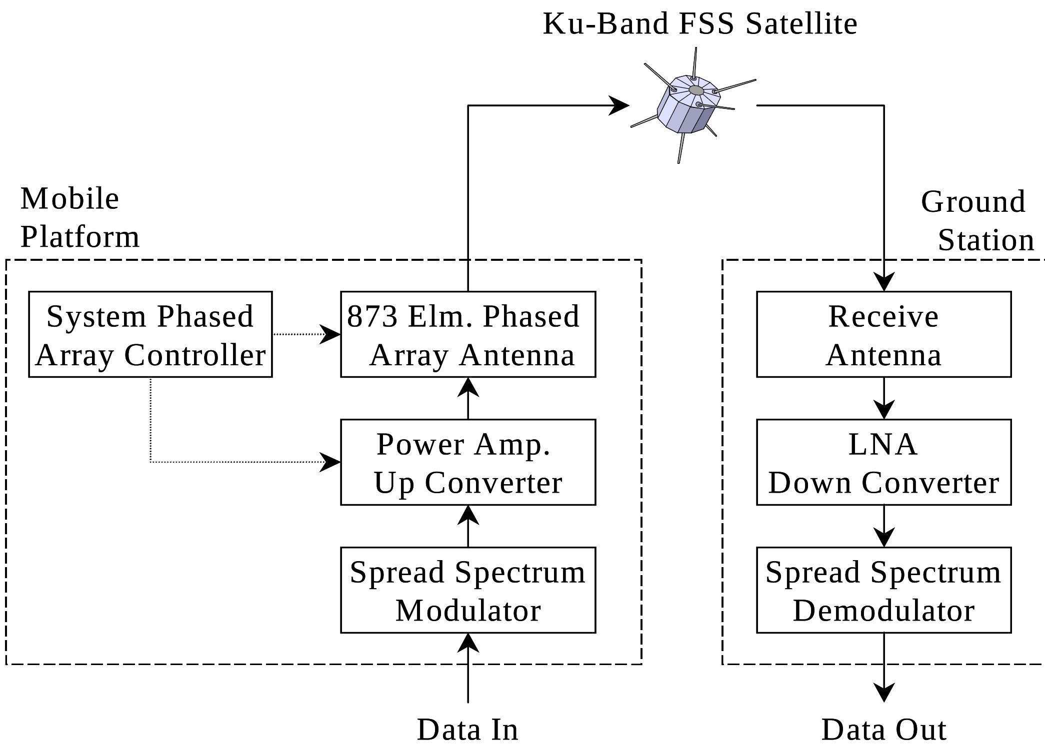

Figure 1. Transmit Antenna Pattern Coordinate Systems

Two spread spectrum modems will be tested. The first is a modified TCDL modem produced by L3 Communications. This modem generates a waveform that is identical to the EB200 modem used by Boeing under its previous experimental license. This waveform is a direct-sequence spread spectrum QPSK modulated signal with a bandwidth of 20 MHz. This modem has 64 kbps and 128 kbps data rates. It uses a concatenated Reed-Solomon and convolutional forward error correction code which results in a threshold Eb/No of 5.5 dB.

The second modem that will be tested is a custom designed modem produced by ViaSat. This modem offers increased bandwidth and reduced threshold Eb/No. The waveform is a direct-sequence spread spectrum off-set QPSK (OQPSK) modulated signal with a bandwidth of 24.3 MHz. This modem has a variable data rates between 16 kbps and 1024 kbps. It uses turbo product forward error correction code which results in a threshold Eb/No of 3.0 dB.

The L-band output from the modem is up converted to Ku-Band, amplified and fed to the 873 element phased array. Both the power amplifier / up converter and the antenna are controlled by the SPAC.

The 873 element phased array is based on the same technology as the 256 element phased array in Boeing's previous experimental application but has a considerably larger aperture area. This improves the gain pattern of the antenna which improves the ability of system to control interference to adjacent satellites. The antenna has a roughly circular active aperture which is approximately 15 inches across.

The beam width of the antenna is 3.1° at zero scan and spreads to approximately 3.1° by 6.2° at a 60° scan angle.

Computed antenna patterns for the 873-element transmit antenna array are shown in Figures 3 through 8. These patterns include typical array fabrication variations. Patterns are given for the normalized gain of the antenna versus longitude along the GSO arc and normalized gain versus latitude perpendicular (North – South) to the GSO arc at the middle of the transmit band, 14.25 GHz. These coordinate systems are shown in Figure 2. Patterns are computed for three cities at the geographic extremities of CONUS: Seattle, Bangor, Brownsville. The projection of the transmit antenna pattern on to the GSO arc does not have a significant heading dependence because the antenna is essentially symmetric in azimuth.

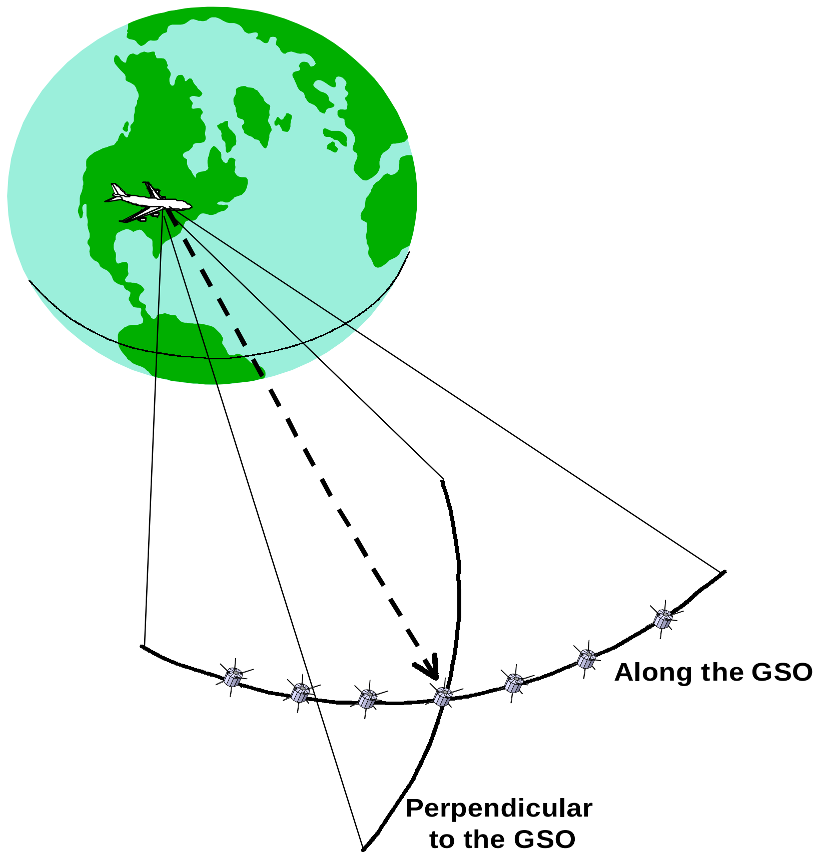

Figure 2. Transmit Antenna Pattern Coordinate Systems

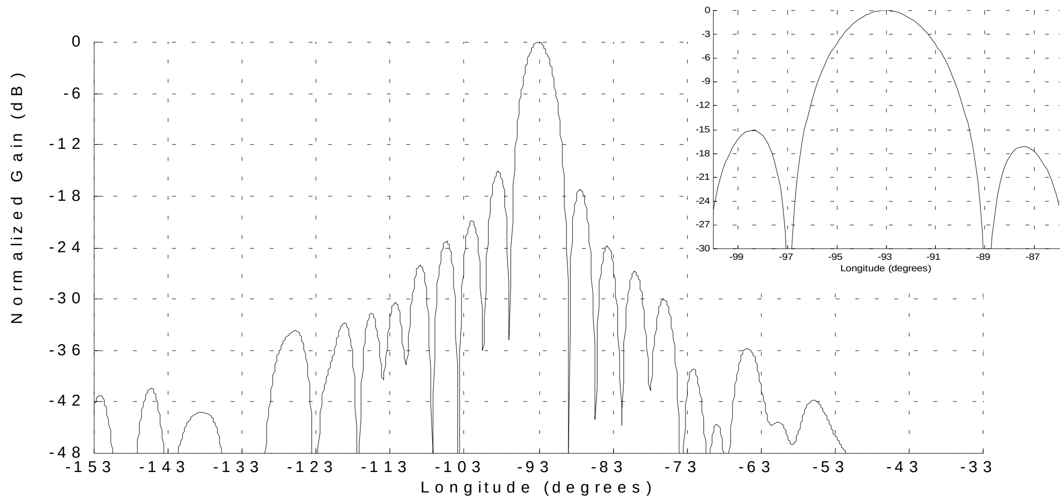

Figure 3. Transmit Antenna Gain Along the GSO Arc From Seattle, WA

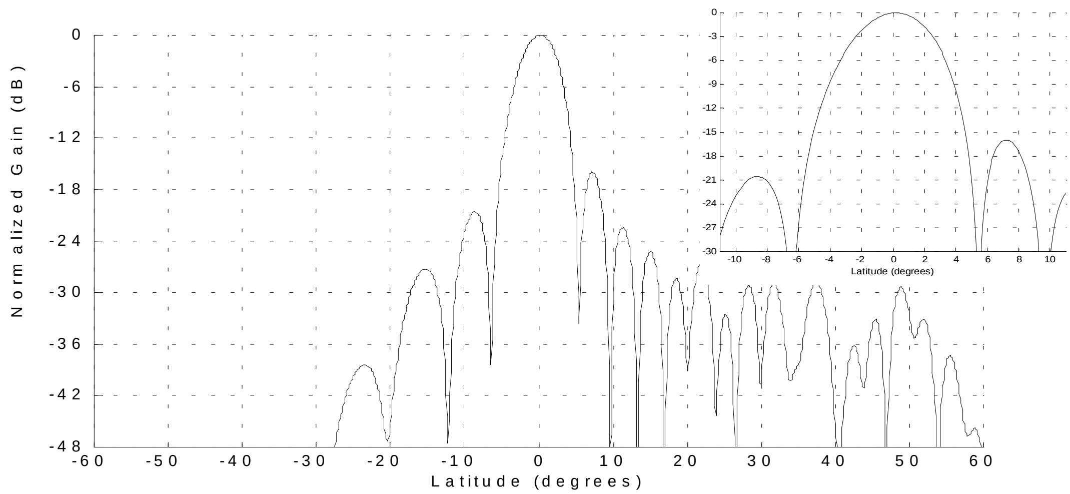

Figure 4. Transmit Antenna Gain Perpendicular to the GSO Arc From Seattle, WA

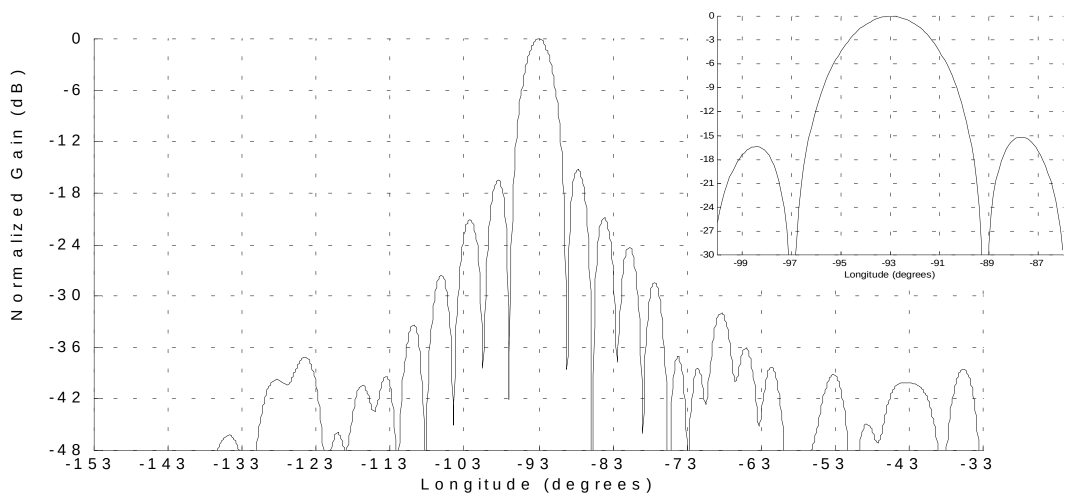

Figure 5. Transmit Antenna Gain Along the GSO Arc From Bangor, ME

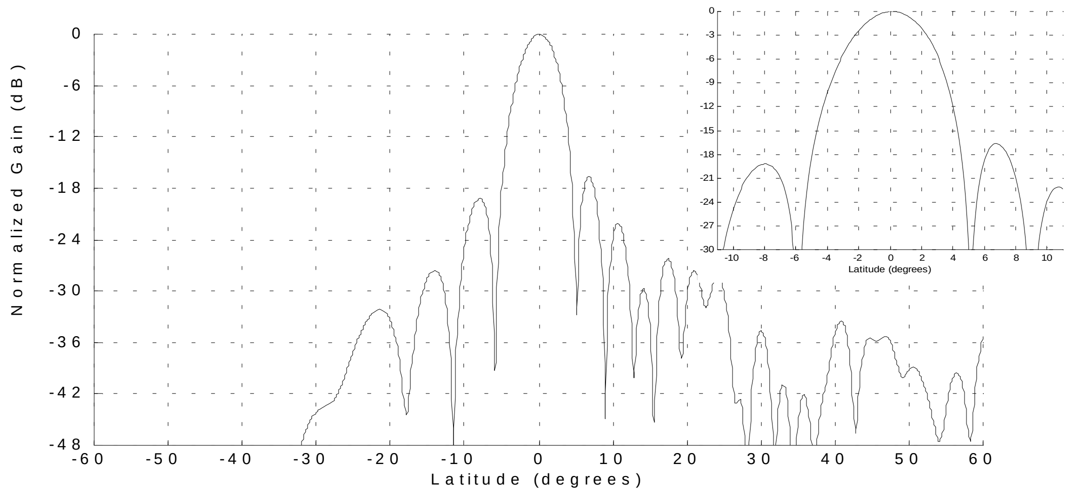

Figure 6. Transmit Antenna Gain Perpendicular to the GSO Arc From Bangor, ME

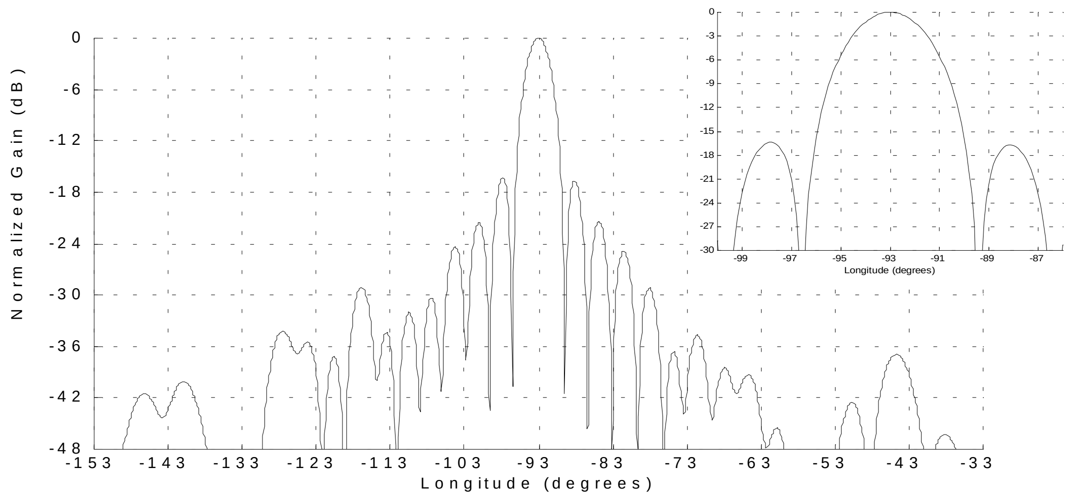

Figure 7. Transmit Antenna Gain Along the GSO Arc From Brownsville, TX

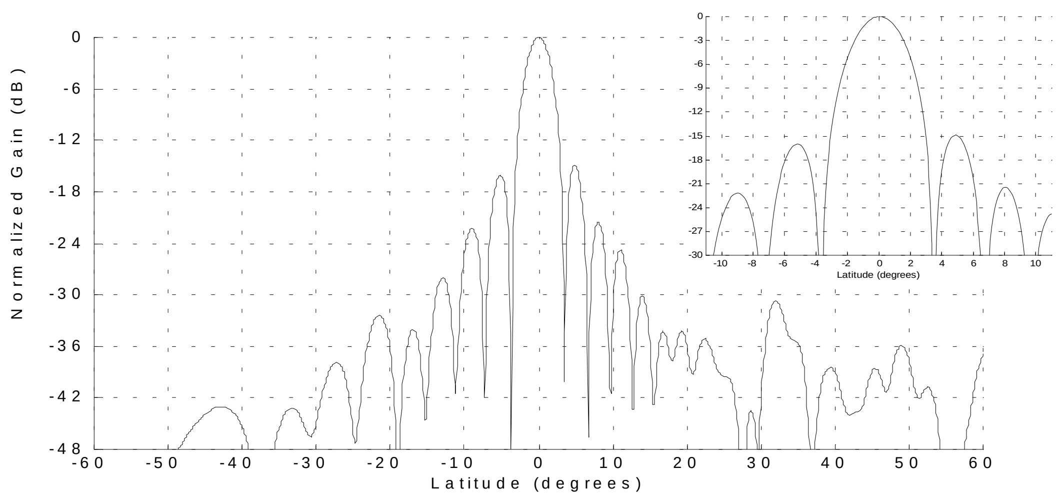

Figure 8. Transmit Antenna Gain Perpendicular to the GSO Arc From Brownsville, TX

The antenna will transmit linear polarization matched to the satellite transponder. This is accomplished by adjusting the angle of the transmitted polarization based on position and attitude information, relative to the satellite, supplied by an aircraft's navigational system or a GPS Attitude System. The SPAC in turn keeps the transmit antenna oriented towards the correct satellite. The beam location is updated up to 100 times every second.

The ground station for the system will use a commercially available dish antenna with a diameter of 4.5 meters or larger to receive the low-level, spread spectrum signal. A conventional low noise amplifier (LNA) and down converter will provide an L-band IF input to the demodulator.

Land and aeronautical mobile platforms in this system will operate within CONUS, Alaska, and Hawaii. The point of communication will be ALSAT Ku.

The EIRP of the system will be limited to 42.9 dBW for the L3 Communications modem and 43.8 dBW for the Viasat modem by limiting the input power into the antenna. The RF power generated by the antenna will vary between approximately 9 W and 26 W depending upon the scan angle of the antenna. When additional transmitters are added to the system for operation on the same transponder, the data rate and EIRP are reduced in a direct relationship to the number of transmitters added. By utilizing the spread spectrum multiple access a number of simultaneous users can be added to the system, at the expense of individual user data rate.

Figure 9 shows link budgets for both the L3 Communications and ViaSat modems for several locations in the US communicating with Telstar-6 at 93° West longitude. This link budget includes the effects of the uplink, downlink, and interference from users of neighboring satellites. The link margin for the L3 Communications modem is in excess of 6 dB because the modem limited to 128 kbps and cannot take advantage of the additional margin. The ViaSat achieves a data rate of 1024 kbps with a link margin of 0.8 dB.

Uplink Summary		L3 Communications Modem			ViaSat Modem		
Transmitter Location		Seattle, WA	Bangor, ME	Brownsville, TX	Seattle, WA	Bangor, ME	Brownsville, TX
Transponder Frequency	GHz	14.250	14.250	14.250	14.250	14.250	14.250
Spread Bandwidth	MHz	20.0	20.0	20.0	24.3	24.3	24.3
Transmit EIRP	dBW	42.9	42.9	42.9	43.8	43.8	43.8
Path Loss	dB	206.6	206.6	206.6	206.6	206.6	206.6
Atmospheric Attenuation	dB	0.10	0.09	0.06	0.10	0.09	0.06
Rain Attenuation	dB	0.50	0.50	0.50	0.50	0.50	0.50
Polarization Tracking Loss	dB	0.04	0.04	0.04	0.04	0.04	0.04
Pointing Loss	dB	0.20	0.20	0.20	0.20	0.20	0.20
Sattellite Gain	dB	30.0	30.0	30.0	30.0	30.0	30.0
Receive Power	dB W	-134.5	-134.5	-134.5	-133.6	-133.6	-133.6
Data Rate	kpbs	128.0	128.0	128.0	1024.0	1024.0	1024.0
	dB Hz	51.1	51.1	51.1	60.1	60.1	60.1
Eb	dB W/Hz	-185.6	-185.6	-185.6	-193.7	-193.7	-193.7
Receive System Temperature	K	794	794	794	794	794	794
	dB K	29.0	29.0	29.0	29.0	29.0	29.0
No	dB W/Hz	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6
Io Adjacent Satellite Uplink	dB W/Hz	-201.9	-201.9	-201.9	-201.9	-201.9	-201.9
No + Io	dB W/Hz	-197.8	-197.8	-197.8	-197.8	-197.8	-197.8
Eb/(No+Io)	dB	12.2	12.2	12.2	4.1	4.1	4.1
End-to-End Summary							
Eb/(No + Io) Uplink	dB	12.2	12.2	12.2	4.1	4.1	4.1
Eb/No Downlink	dB	24.8	24.8	24.8	16.7	16.7	16.7
Eb/(No+Io) End-to-End	dB	12.0	12.0	12.0	3.8	3.8	3.9
Eb/No Required	dB	5.5	5.5	5.5	3.0	3.0	3.0
Link Margin	dB	6.5	6.5	6.5	0.8	0.8	0.9

Figure 9. Link Budget

In order to show that the link does not cause unacceptable levels of interference to the adjacent satellites, an off-axis EIRP density analysis was conducted for this system. Figures 10 through 12 show the off-axis EIRP density of the system plotted against the off-axis EIRP density mask defined by –14 dBW/4 kHz from 25.134(b) into a 25.209 gain mask for several locations in the US. This off-axis EIRP density mask forms the coordination threshold for very small aperture terminals. The peak EIRP density of the system is approximately 6.0 dBW /4 kHz. This gives a peak EIRP of 42.9 dBW for the 20 MHz L3 Communications modem waveform and 43.8 dBW for the 24.3 MHz Viasat modem waveform. The off-axis EIRP density of the system is at least 5 dB below the off-axis EIRP density mask at all points; thus, the Boeing system will not cause unacceptable or harmful interference.

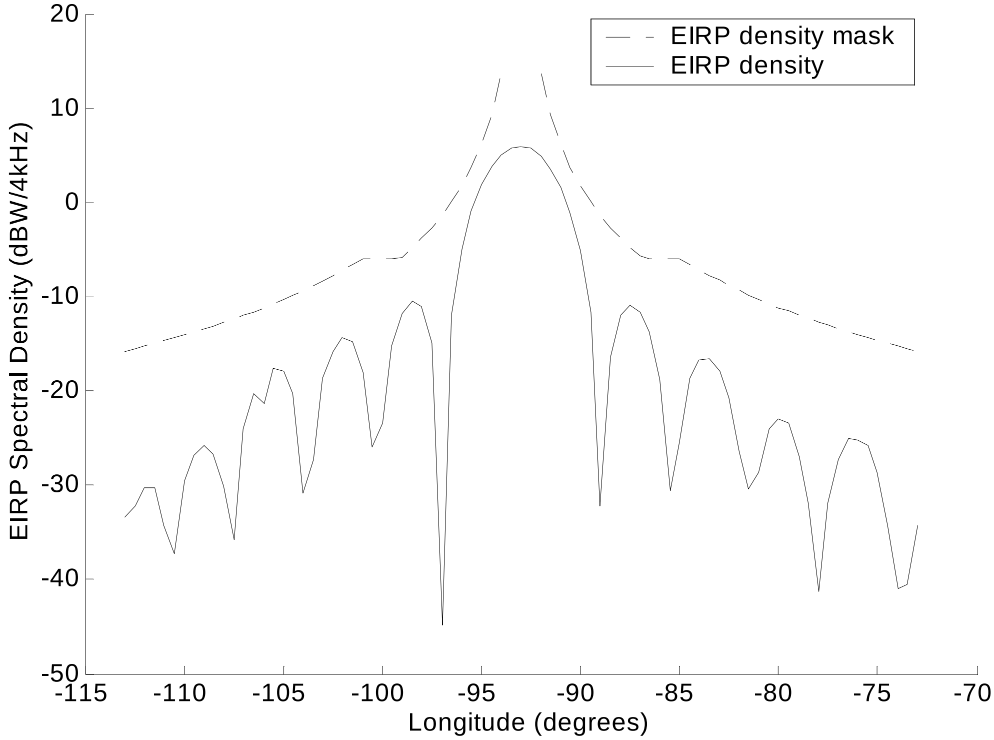

Figure 10. Off-axis EIRP Density Along the GSO From Seattle, WA

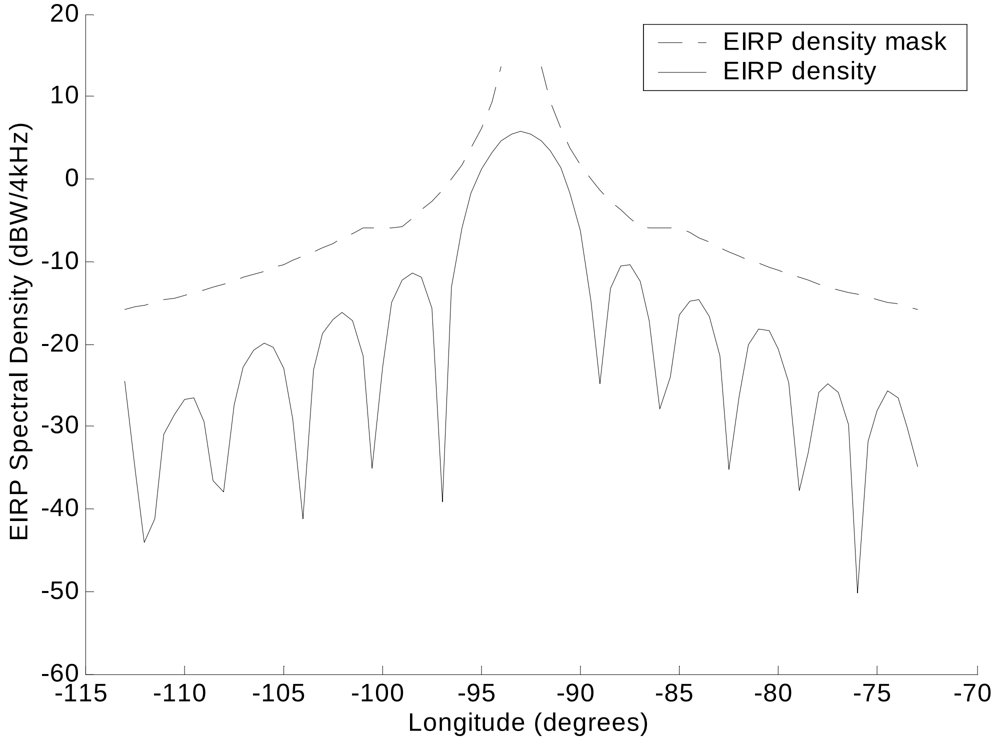

Figure 11. Off-axis EIRP Density Along the GSO From Bangor, ME

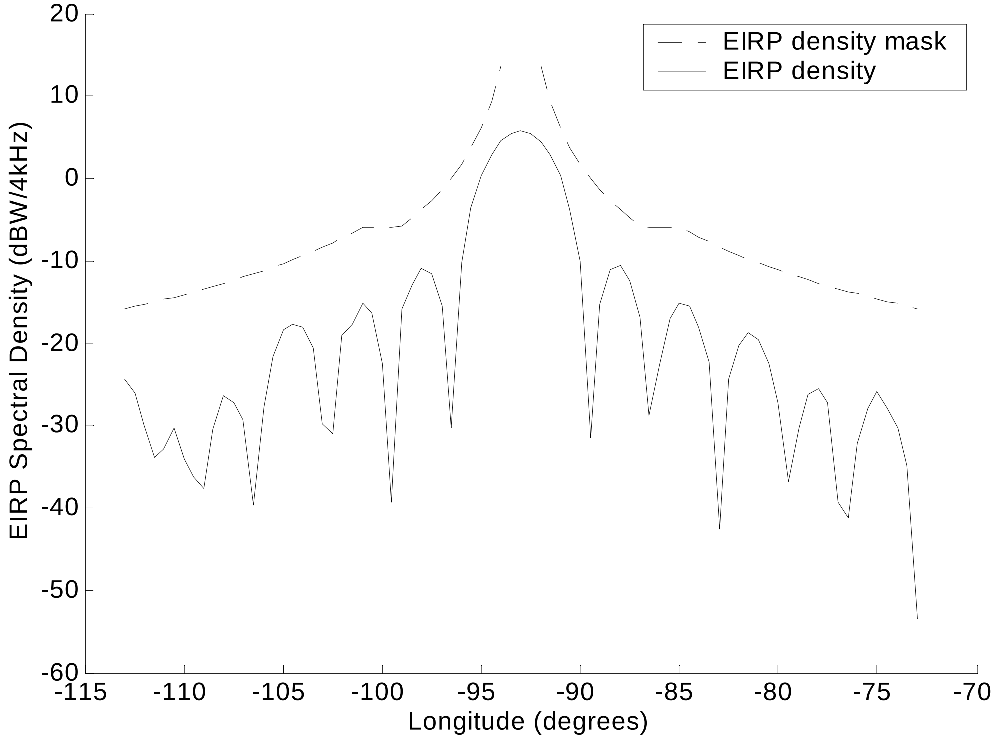

Figure 12. Off-axis EIRP Density Along the GSO From Brownsville, TX

Summary:

Granting of this experimental license will enable Boeing to continue the development of low-cost, data-communications systems that can provide communications connectivity to mobile platforms. The development of this communications system will provide airlines with greater visibility of aircraft operations, resulting in improved servicing and maintenance of the aircraft fleet. It will also provide airline customers with more versatile in-flight services. Military customers will have real-time access to time critical information and the means to participate in multi-party videoconferences between airborne and ground units.

Accordingly, the grant of this experimental license application would be in the public interest.