EXHIBIT
GE-Americom Earth Station (E920698) Woodbine, Maryland
Compliance with FCC Report & Order (FCC96-377) for the 13.75 - 14.0 GHz Band
Analysis and Calculations

1. Background

This Exhibit is presented to demonstrate the extent to which the proposed satellite earth station application for Woodbine, Maryland is in compliance with FCC REPORT & ORDER 96-377 and how the proposed earth station will impact shipboard radiolocation operations (RADAR) and the NASA space research activities also in the 13.75 - 14.0 GHz Band.

Table 1. Earth Station Characteristics

• Coordinates:	39° 22' 33" N, 77° 04' 54" W
• Ground Elevation:	578.5 feet above mean sea level
• Satellite Location for Earth Station:	Domestic Arc, 55° to 145° W
• Frequency Band:	13.75-14.0 GHz for uplink 11.45-11.7 GHz for downlink
• Polarizations:	Dual linear, V and H
• Modulation	Four Carriers, (3)Digital FM, (1) CW TT&C and IOT-CW Digital Bandwidths 400 kHz
• Maximum Required Uplink EIRP:	85.0 dBW per Digital Carrier 63.7 dBW /4 kHz 68.0 dBW CW
• Transmit Antenna Characteristics	
Antenna Size:	9.2-meters in Diameter
Antenna Type/Model:	Satcom Technology 9200K
Gain:	60.2 dBi
• RF power into Antenna Flange:	3.5 dBW/4 kHz Digital 7.8 dBW CW
• Elevation Angle:	39.0° @ Sat 55° W, Az 147.4° (Min) 44.4° (Max) @ Sat 72° W, 172° Az 8.3° (Min) @ Sat 145° W, 255.6° Az
• Side Lobe Antenna Gain:	32- 25*log(θ), or ≥ -10 dB

Because the above spectrum is shared with the Federal Government, coordination in this band requires resolution data pertaining to potential interference between the earth station and both Navy Department and NASA systems. Potential interference from the earth station could impact with the Navy and/or NASA systems in five areas. These areas are noted in FCC Report and Order 96-377 dated September 1996, and consist of (1)

Radiolocation and radio navigation, (2) Data Relay Satellites, (3) Precipitation Radar, (4) Altimeters, and (5) Scatterometers.

Summary of Coordination Issues:

1) Potential Impact to Government Radiolocation (Shipboard RADAR)
2) Potential Impact to NASA Data Relay Satellite Systems (TDRSS)
3) Potential Impact to NASA/NASDA Operations (Precipitation RADAR)
4) Potential Impact to NASA Operations (Altimeters)
5) Potential Impact to NASA Operations (Scatterometers)

2. Potential Impact to Government Radiolocation (Shipboard RADAR)

Radiolocation operations (RADAR) may occur anywhere in the 13.4 - 14 GHz frequency band onboard ocean going United States Navy ships. The Federal Communication Commission (FCC) order 96-377 allocates the top 250 MHz of this 600 MHz band to the Fixed Satellite Service (FSS) on a co-primary basis with the radiolocation operations and provides for an interference protection level of –167 dBW/M^2/4 kHz.

The closest distance to the Atlantic Ocean from the Woodbine, Maryland earth station site is approximately 114 miles. This was to the shoreline at Lewes, Delaware at the mouth of Cape May and the Atlantic Ocean. The calculation of the power spectral density at this distance is given by the following equation.

$$P_d = (P_e * G_e) * OH * S / ((4\Pi) * R^2)$$

Where,

P_d = Earth station radiated power spectral density, dBW/M^2/4 kHz or Watts/M^2/4 kHz
P_e = Earth station transmitted power spectral density, 3.5 dBW/ 4 kHz or 7.8 dBW CW
G_e = Gain of the earth station antenna in the direction of the ocean surface, -10 dB or 0.1
OH = Over-the –Horizon propagation loss factor from NBS Technical Note 101, dB or Number, 40.8 dB for the relative heights of the earth station and RADAR antenna at the separation distances to the shoreline.
S = Terrain blockage determined from the computer path profile from the earth station to the ocean, 69.2 dB
R = Distance to the Atlantic Ocean shoreline from earth station location, 183,512 meters
114 miles = 183,512 meters (Location Lewes, Delaware at Mouth of Cape May)

The calculated P_d to the closest shoreline location was –232.8 dBW/M^2/4kHz.

The calculation for the path indicated that the interfering level generated by the earth station toward the ocean would be at least 64.5 dB below the interference criteria of the FCC R&O 96-377. Therefore, there should be no interference into the U.S. Navy RADAR from the GE-Americom Woodbine, Maryland (E920698) earth station because of the terrain blockage and over-the horizon propagation between the Woodbine, Maryland location and the Atlantic Ocean.

3. Potential Impact to NASA's Data Relay Satellite System (TDRSS)

The geographic location of the GE-Americom earth station (E920698) in Woodbine, Maryland is outside the 390 KM radius coordination contour surrounding NASA's White Sands, New Mexico ground station complex. Therefore, the TDRSS space-to-earth link will not be impacted by the GE-Americom earth station at Woodbine, Maryland.

The TDRSS space-to-space link (13.772 to 13.778 GHz) band is assumed to be protected if an earth station produces an EIRP less than 71dBW/6 MHz in this band. The 9.2-meter earth station antenna will have an EIRP of 85 dBW Digital and an EIRP of 68 dBW CW in this band. Therefore, to avoid interference to the TDRSS space-to-space link, the Woodbine earth station when operated in the digital mode should either; not be tuned to the frequencies in the 13.772 to 13.778 GHz Band, or the EIRP level must be reduced by at least 14 dB.

4. Potential Impact to NASA/NASDA Operations (Precipitation RADAR)

The Tropical Rain Measuring Mission (TRMM) Precipitation RADAR (PR) operates at two frequencies 13793 and 13805 MHz with a bandwidth of 600 kHz at each frequency. The FCC Report and Order 96-377 grants NASA protection to the spacecraft borne sensors like those used for the TRMM in the 13.75 to 14.0 GHz band until January 1, 2000. The 9.2-meter antenna system will have an EIRP of 85 dBW/400 kHz or 68 dBW for CW (Maximum).

The ITU-R SA. 1071 states that the recommended threshold of interference at the two TRMM frequencies is -150 dBW. The geographic location of the GE-Americom earth station antenna is outside the TRMM PR "ground truth" exclusion zones described in ITU-R SA. 1071. For the earth station antenna location, the antenna coupling to the space borne antennas can be earth station sidelobe to TRMM PR sidelobe, and earth station side lobe to TRMM PR main beam. The coupling to the TRMM PR main beam is the worst case; therefore, it will be the one calculated. The calculation will be made for an overhead pass of the TRMM PR satellite having a ±17° cross-track scan. The calculation will be made for scan angles of 0°, 8.5° and 17° and earth station elevation angles of 4.5° and 50.1°.

Table 2. Calculation Parameters for TRMM PR

The parameters for the calculation are:	
TRMM Range @0° Scan Angle:	350 km
TRMM Range @8.5° Scan Angle:	354 km
TRMM Range @ 17° Scan Angle:	366 km
TRMM Antenna Gain:	17.7dBi
Earth Station Elevation Angle (1):	8.3°
Earth Station Elevation Angle (2):	44.4.°
6.1-meter Antenna Gain:	60.2 dBi
Earth Station Side Lobe Antenna Gain:	32 - 25*log(θ) or, ≥ -10 dB Where θ is the angle between the Earth Station antenna and the TRMM antenna.
Transmit Power	7.8 dBW CW
Transmit Power	24.8 dBW/600 kHz
*FSL @ 350 km	166.2 dB
FSL @ 354 km	166.3 dB
FSL @ 366 km	166.6 dB

*FSL is free space loss

Table 3. TRMM PR Calculated Results

6.1-meter Antenna   Transmit Power = 7.8 dBW CW and 24.8 dBW/600 kHz

*ES Antenna EL 8.3°-CW Results					
Scan Angle	**ES Antenna Gain**	**TRMM Gain**	**FSL**	**Power Received**	**Margin**
0°	-10 dBi	17.7 dBi	166.2 dB	-150.7 dBW	+ 0.7 dB
8.5°	-10 dBi	17.7 dBi	166.3 dB	-150.8 dBW	+ 0.8 dB
17.0°	-10 dBi	17.7 dBi	166.6 dB	- 151.1 dBW	+ 1.1 dB

ES Antenna EL 8.3°- 600 kHz Results					
Scan Angle	**ES Antenna Gain**	**TRMM Gain**	**FSL**	**Power Received**	**Margin**
0°	-10 dBi	17.7 dBi	166.2 dB	-133.7 dBW	- 16.3 dB
8.5°	-10 dBi	17.7 dBi	166.3 dB	-133.8 dBW	- 16.2 dB
17.0°	-10 dBi	17.7 dBi	166.6 dB	- 134.1 dBW	- 15.9 dB

ES Antenna EL 44.4°-CW Results					
Scan Angle	**ES Antenna Gain**	**TRMM Gain**	**FSL**	**Power Received**	**Margin**
0°	-9.6 dBi	17.7 dBi	166.2 dB	-150.3 dBW	+ 0.3 dB
8.5°	-7.4 dBi	17.7 dBi	166.3 dB	-148.2 dBW	- 1.8 dB
17.0°	-4.6 dBi	17.7 dBi	166.6 dB	- 145.7 dBW	- 5.3 dB

ES Antenna EL 44.4°- 600 kHz Results					
Scan Angle	**ES Antenna Gain**	**TRMM Gain**	**FSL**	**Power Received**	**Margin**
0°	-9.6 dBi	17.7 dBi	166.2 dB	-133.3 dBW	- 16.7 dB
8.5°	-7.4 dBi	17.7 dBi	166.3 dB	-131.2 dBW	- 18.8 dB
17.0°	-4.6 dBi	17.7 dBi	166.6 dB	- 128.7 dBW	- 21.3 dB

*ES is earth station

From the calculated results the earth station will not meet the interference criteria for a transmit power of 7.8 dBW CW or 24.8 dBW/600kHz for all antenna elevations and modulations. Therefore, the earth station at Woodbine (E92698) should not be operated on the frequencies of the TRMM PR at these transmit powers. That is, 13793 MHz ± 300 kHz and 13805 ± 300 kHz should be excluded frequencies for the Woodbine, Maryland earth station until after January 1, 2000. If the system transmit powers can be reduced by the indicated negative margin numbers for both the digital and CW modes of operation, the interference criteria for the TRMM PR will be satisfied.

Even though the Woodbine, Maryland earth station is within ± 55° latitude, and the elevation angles can vary from 8.8° to 44.4°, which are below the maximum of 71° recommended in the ITU-R SA.1071, the levels calculated indicate there will be an interference conflict at the operational frequencies of the TRMM PR unless the EIRP is reduced by the margins calculated.

5. Potential Impact to Altimeter Operations

There are two types of airborne RADAR altimeters operating in the 13.75 - 14.0 GHz band that are of concern with respect to interference from earth stations. They are the TOPEX-POSEIDON and the ERS-1/2. These RADAR altimeters are downward looking pulsed-RADAR installed on orbiting spacecraft. These systems are used to very precisely measure range from the satellite to the surface of the earth. In addition to the operational RADAR in this band, a number of other systems are planned in the future. The parameters for the operational RADAR in this band are listed below.

Table 4. Altimeter Interference Criteria

RADAR System	Frequency of Operation	Interference Criteria
TOPEX-POSEIDON (1)	13.60 GHZ ◊ 160 MHz	- 117 dBW/320 MHz
TOPEX-POSEIDON (2)	13.65 GHz ◊ 160 MHz	- 130 dBW/320 MHz
ERS -1/2	13.77 GHz ◊ 165 MHz	- 120 dBW/330 MHz

The orbiting spacecraft, with the RADAR altimeter, is assumed to be at an altitude of 800 km. The slant range from the earth station to the spacecraft at the minimum elevation angle (8.3°) is 5229 km, and from the earth station to the spacecraft at the maximum elevation angle (44.4°) is 1143 km, when the earth station main beam illuminates the spacecraft. This is the worst case alignment of the earth station antennas and the spacecraft RADAR antenna. It will occur when the spacecraft travels through the main beam circle formed by the earth station antenna. The time it takes the spacecraft to travel through this circle in space is a function of the 20-dB beam width of the earth station antennas (the 20-dB beam width is used according to ITU Ap28 calculation methods) and the speed of the of the spacecraft. The spacecraft is traveling at 6.5 km/sec and the 20-dB beam width of the 9.2-meter antenna is estimated to be 0.37°. The diameter of the circle in space formed by the 9.2-meter antenna at a range of 5229 km is 33.8-km and 7.4-km at a range of 1123 km. The spacecraft will pass through the beam width of the earth station antenna at the minimum elevation angle in approximately 5.2 seconds and the antenna beam at the maximum elevation angle in 1.1 seconds. During these times there may be a small blip of noise introduced into the RADAR output but it would be so transitory it may go unnoticed.

The availability requirement for the NASA altimeter data is 95%, which assumes that the associated individual outages are brief and randomly dispersed over all observation times and areas. If the outage were due to only one earth station the 95% availability would not be a problem. However, the outage caused by multiple earth stations and other causes such as intense rainfall must be accounted for in determining the net availability of the system. The earth station interference will occur in a predictable manner for a given area so it cannot be considered random. Because of its predictability and relatively short time duration, earth stations should have very little impact on the operation of present RADAR systems, and processing circuits and/or procedures can be designed in future systems to minimize the effect of the interference from single or multiple earth stations.

In order to calculate the interference level to the altimeter radar, we will assume that the RADAR antenna side lobe gain toward the earth station antenna is -10 dB. Since the earth stations signal is narrow band compared to the RADAR bandwidth, the signals will be totally captured by the radar receiver. The following parameters are used in the calculation:

FSL for ES Antenna for Minium Elevation:	189.8 dB
FSL for ES Antenna for Maximum Elevation:	176.6 dB
Atmospheric Absorption:	0.2 dB
EIRP 9.2-meter ES Antenna:	85.0 dBW Digital
	68.0 dBW CW

Table 5. Altimeter Calculated Results

Earth Station 8.3° Elevation for 85.0 dBW Digital		
RADAR Receiver	**Interference Level**	**Margin**
TOPEX-POSEIDON (1)	- 115.0 dBW	- 2.0 dB
TOPEX-POSEIDON (2)	- 115.0 dBW	- 15.0 dB
ERS-1/2	- 115.0 dBW	- 5.0 dB

Earth Station 44.4° Elevation for 85.0 dBW Digital		
RADAR Receiver	**Interference Level**	**Margin**
TOPEX-POSEIDON (1)	- 101.8 dBW	- 15.2 dB
TOPEX-POSEIDON (2)	- 101.8 dBW	- 28.2 dB
ERS-1/2	- 101.8 dBW	- 18.2 dB

Earth Station 8.3° Elevation for 68.0 dBW CW		
RADAR Receiver	**Interference Level**	**Margin**
TOPEX-POSEIDON (1)	- 132.0 dBW	+ 15.0 dB
TOPEX-POSEIDON (2)	- 132.0 dBW	+ 2.0. dB
ERS-1/2	- 132.0 dBW	+ 12.0 dB

Earth Station 44.4° Elevation for 68.0 dBW CW		
RADAR Receiver	**Interference Level**	**Margin**
TOPEX-POSEIDON (1)	- 120.8 dBW	+ 3.8 dB
TOPEX-POSEIDON (2)	- 120.8 dBW	- 9.2 dB
ERS-1/2	- 120.8 dBW	+ 0.8 dB

The comparison of the calculated levels to the interference criteria indicates that there will be interference coupled to the altimeters. The highest interference levels will be generated by the earth station at the maximum elevation angle and with but will occur for the shortest time duration, 1.1 seconds. Interference from the earth station for CW operation will only effect the TOPEX-POSIDEN (2) altimeters. The digital operation of the earth station may cause interference to all the altimeters. Even though potential interference is predicted to be generated by the earth station at Woodbine the net result does not prevent the 95% availability of the RADAR data. The maximum interference duration will occur only if the earth station is at its lowest operational elevation angle. This condition will seldom occur as the majority of the time the earth station will not be operational, and when it is any of the elevation angles between 8.3° and 44.4° are equally likely. If the earth station system were operational for 8 hours a month and during the operational time the satellite altimeter passed through the earth station antenna beam when it was at its highest and lowest elevation angles on each of its orbits the down time would be 6.3 seconds. The data availability value of this improbable scenario on the RADAR altimeter data would be 99.9125 % per orbit, or 99.99975 % per month well above the 95 % availability desired. From this worst case analysis it can be determined that the interference effect on the satellite altimeter data availability is miniscule. Therefore, it can be concluded that the earth station at Woodbine will have an insignificant effect on the RADAR data availability.

The Woodbine, Maryland location of the earth station is located it outside the TOPEX-POSEIDON critical exclusion zone as defined in the ITU-R Recommendation SA. 1071. The operational elevation look angles for the earth station are anywhere from 8.3° to 44.4°. These elevation angles are below the 71°-elevation angle limitation required until January 1, 2001 in ITU-R Recommendation SA-1071.

6. Potential Impact to NASA Scatterometer Operations

Scatterometers are spacecraft borne RADAR type devices that measure the near surface vector winds over the ocean. Wind data over the oceans is considered a critical parameter in the determination of weather patterns and global climate. The overall availability requirement of the scatterometer system is similar to the altimeter RADAR. That is, some data loss is tolerable when interference signals exceed interference thresholds. The scatterometers can lose 1% of the ocean data from interference occurring systematically or 5% when the interference is occurring randomly. The scatterometers operate at a center frequency of 13995 MHz . 1.44 MHz. There are two types of antenna modes of operation, fan beam and spot beam. For fan beam operations the aggregate interference threshold is - 174 dBW/2 kHz, while for spot beam operations, - 155 dBW/10 kHz. ITU-R SA. 1071 Recommendations state that to protect scatterometers using fan beams from unacceptable interference until 1 January 2000, FSS earth stations should not exceed an EIRP density toward the scatterometer orbit (over the oceans) of 25 dBW in any 2 kHz band between 13.99356 GHz and 13.99644 GHz. The GE-Americom earth station at Woodbine, Maryland can produce an EIRP that is greater than 25 dBW/2 kHz in the scatterometer frequency band. Therefore, the earth station at Woodbine should not operate in this band to prevent interference problems with the scatterometers. This frequency exclusion should be reexamined after January 1, 2000 to see if the interference criterion for the scatterommeters has actually expired or has been changed.

7. Coordination Issue Result Summary and Conclusions

The results of the analysis and calculations performed in this exhibit indicate that no interference will occur between the earth station at Woodbine, Maryland and the U.S. Navy RADAR operations. The results also show that compatible operations with NASA systems are possible based upon operational restrictions. These restrictions involve avoidance of certain frequency ranges or the reduction of EIRP by the earth station when using the frequency range so that interference will not occur to NASA operations. Table 6 provides a list of the operational restrictions

Table 6. Operational Restrictions for GE-Americom Earth Station, Woodbine

System	Frequency Restriction (or) MHz	EIRP Reduction dB
TDRSS	13,772.0 – 13,778.0	14 Digital 0 CW OK
TRMM PR	13,792.7 – 13,793.3	*
TRMM PR	13,804.7 - 13,805.7	*
Scatterometers	13,993.56 – 13,996.44	*

*Reduction in EIRP to avoid interference condition may violate the minimum required EIRP stated in R&O 96-377.

GE-Americom will exclude the above listed frequencies from their earth station operations, or where possible, reduce their EIRP when operating on these frequencies.

The NASA altimeter data availability requirement of 95% will not be degraded by the Woodbine earth station opeations.

No interference from the Woodbine, Maryland earth station into U.S. Navy RADAR operations will occur.