Exhibit For
Hawaii Pacific Teleport
Call Sign E150010
Kapolei, Hawaii
Satcom Technologies 9 Meter Earth Station

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 Hawaii Pacific Teleport satellite earth station is in compliance with FCC REPORT & ORDER 96-377. The potential interference from the earth station to US Navy shipboard radiolocation operations (RADAR) and the NASA space research activities in the 13.75 - 14.0 GHz Band is addressed in this Exhibit. The parameters for the earth station are:

Table 1. Earth Station Characteristics

- Coordinates (NAD83): 21°20' 12.0" N, 158° 05' 25.2" W
- Satellite Range for Earth Station: Eutelsat 172B (172° E)
- Frequency Band: 13.75-14.0 GHz for uplink
- Polarizations: H,V
- Emissions: 4M00G7W, 36M0G7W
- Modulation: Digital
- Maximum Aggregate Uplink EIRP: 68.0 dBW for the 4 MHz Carriers
- Transmit Antenna Characteristics
  - Antenna Size: 9.0 meters in Diameter
  - Antenna Type/Model: Satcom Technologies
  - Gain: 60.1 dBi
- RF power into Antenna Flange

	4 MHz	36MHz
	16.0 dBW	16.0 dBW
	-14.0 dBW/4 kHz (Max)	-14.6 dBW/4 kHz

Minimum Elevation Angles:
Kapolei, Hi. 48.0° @ 237.7° Az.

- Side Lobe Antenna Gain: 32 - 25*log(θ)

Because the above uplink 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 two 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.

<u>Summary of Coordination Issues</u>:

1) Potential Impact to Government Radiolocation (Shipboard Radar)
2) Potential Impact to NASA Data Relay Satellite Systems (TDRSS)

2. Potential Impact to Government Radiolocation (Shipboard Radar)

Radiolocation operations (RADAR) may occur anywhere in the 13.4 - 14 GHz frequency band aboard 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 shoreline from the Kapolei, Hawaii earth station is approximately 4.0 km southwest toward the Oceanfront. The calculation of the power spectral density at this distance is given by:

	4 MHz	36 MHz
1. Clear Sky EIRP (dBW):	76.1	85.0
2. Carrier Bandwidth:	4 MHz	36 MHz
3. PD at antenna Input: (dBW/4 kHz)	-14.0	-14.6
4. Transmit Antenna Gain:	60.1 dBi	60.1 dBi
5. Antenna Gain Horizon:	FCC Reference Pattern	FCC Reference Pattern
6. Antenna Elevation Angle:	48.0°	48.0°

The earth station will radiate interference toward the Kapolei. Hawaii Coastline according to its off-axis side-lobe performance. A conservative analysis, using FCC standard reference pattern, results in off-axis antenna gains of -10.0 dBi toward the Coastline.

The signal density at the shoreline, through free space is:

4 MHz Carriers

PFD = Antenna Feed Power density (dBW/4 kHz) + Antenna Off-Axis Gain (dBi) – Spread Loss (dBw-m^2).

= -14.0 dBw/4 kHz + (-10.0) dBi – 10*log[4Π*$(4000m)^2$]
= -107 dBW/m^2/4 kHz + Additional Path Losses (~10.1 dB)
= -117.1 dBW/m^2/4 kHz

36 MHz Carriers

PFD = Antenna Feed Power density (dBW/4 kHz) + Antenna Off-Axis Gain (dBi) – Spread Loss (dBw-m^2).

= -14.6 dBw/4 kHz + (-10.0) dBi – 10*log[4Π*$(4000m)^2$]
= -107.6 dBW/m^2/4 kHz + Additional Path Losses (~10.1 dB)
= -117.7 dBW/m^2/4 kHz

Our calculations show additional path loss of approximately 10.1 dB including absorption loss and earth diffraction loss for the actual path profiles from the proposed earth station to the nearest shoreline. Please note these losses include above ground clutter in the direction of the shoreline.

The worst case calculated PFD including additional path losses to the closest shoreline location is –117.1 dBW/m^2/4 kHz for all carriers. This is 49.9 dB above the –167 dBW/m^2/4 kHz interference criteria of R&O 96-377.

In an effort to analyze the effects of earth station transmissions on naval radar systems, power flux densities were calculated from the earth station to the shipboard radars in increments from 15.5 miles to 60 miles (See Table 2). The calculation of interference level to the RADAR sidelobes was made at the initial distance of 15.5 miles. A distance of 15.5 miles (25 Km.) was used as the initial increment because it is the distance from the earth station site to the offshore operating shipping lane. This is the worst case condition. If the interference level is below the criteria at this range, it will be below the criteria at all of the greater ranges. A power flux density was also calculated from the shipboard radars to the shoreline and the reflection of the radar transmissions back to the radar. Since this flux density concerns the transmission from the ship to shore and back to the ship the mileage number is doubled. The power flux densities are based on the following formulas:

<u>Earth Station to Naval Radars</u>

$$P_{FD} = P_{ES}G_{ES} / 4\pi r^2$$

Where: P_{FD} = Power Flux Density
P_{ES} = Power of Earth Station (-14.0 dbW/4 kHz)

G_{ES} = Worst Case Earth Station Gain Toward the Shipboard Radars (-10 dB)
$4\pi = 10Log(4\pi) = -11.0$
r = Distance from ES to radars in Meters [Used 20Log(r)]

<u>Naval Radars to Shore and Reflection back to the Radar Source</u>

$$P_{FD} = P_T G_T \ / \ 4\pi \ (2r)^2 * (0.01 \ m^2)$$

Where: P_{FD} = Power Flux Density
P_T = Power of Radar (Used 56.0 dBW for 3.65 MHz)
G_T = Gain of Radar (Used 44 dB)
$4\pi = 10Log(4\pi) = -11.0$
2r = Distance to Shoreline and Reflection back to Radar Source
$0.01m^2$ = Size of the Radar Sectional Area of Target

Based upon calculations from the above formulas, it was determined that reflections of the radar transmissions from the shoreline and back to the radar were 69.1 dB higher than the earth station transmissions into the radar.

These calculations are presented in the tables below. This being the case, it can be concluded that in the main beam, earth station operations should not be a problem for naval radar operations.

Table 2

Distance from ES to Radar (Miles)	Flux Density Interference From ES ($dBW/4 kHz/m^2$)	Desired Radar Return from $(0.01m)^2$ Target ($dBW/4 kHz/m^2$)	Radar Signal ES Interference (dB)
15.5	-117.1	-63.2	53.9
20.0	-121.3	-67.4	53.9
30.0	-125.2	-71.3	53.9
40.0	-127.5	-73.6	53.9
50.0	-129.1	-75.2	53.9
60.0	-131.5	-77.6	53.9

The worst-case calculated PFD, which includes 10.1 dB of additional path losses to the shoreline location is –117.1 $dBW/m^2/4$ kHz. If off axis, side lobe considerations are made, 44 dB was used as the gain of the radar and -10.0 dBi was the radar antenna side lobe gain toward the direction of the earth station. This additional -54.0 dB will create an equivalent PFD of -171.1 $dBW/m^2/4$ kHz, which is 4.1 dB lower than the –167 $dBW/m^2/4$ kHz interference criteria of R&O 96-377.

Therefore, there should be no interference to the US Navy RADAR from the Kapolei earth station in both the main beam and side lobe of the radar.

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

The geographic location of the Hawaii Pacific Teleport earth station in Kapolei, Hawaii 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 Hawaii Pacific Teleport earth station in Kapolei, Hawaii.

The TDRSS space-to-space link in the 13.772 to 13.778 GHz band is assumed to be protected if an earth station produces an EIRP less than 71 dBW/6 MHz in this band. The 9 meter earth station antenna will have an EIRP less than 71 dBW/6 MHz for both the 4 MHz and 36 MHz carriers in this band. The EIRP will be reduced to 76.9 dBW for the 36 MHz carrier across this band with a 70.9 dBW/6 MHz per segment power. The EIRP will be reduced to 71.5 dBW for the 4 MHz carrier across this band with a 70.8 dBW/6 MHz per segment. There should not be any interference to the TDRSS space-to-space link for any of the carriers proposed at Kapolei in this band.

4. Coordination Issue Result Summary and Conclusions

The results of the analysis and calculations performed in this Exhibit indicate that compatible operations between the earth station at the Kapolei facility and the US Navy and NASA systems space-to-earth link and NASA systems space-to-space link (13772.0 to 13778.0 MHz) will be permitted for all proposed carriers.