**EXHIBIT B**
**HNS License Sub, LLC**
**Modification of License Application**
**September 2011**

# DEMONSTRATION OF JUPITER 107W TT&C SYSTEM COMPLIANCE WITH SECTION 25.138(a) OF THE FCC'S RULES

Earth stations transmitting in the frequency bands 28.35-28.6 GHz and 29.25-30.0 GHz are required to meet the off-axis EIRP performance levels provided in §25.138(a) of the Commission's Rules so as to prevent unacceptable interference into adjacent satellites. In this exhibit, includes an explicit compliance demonstration in regards to the off axis performance of the new 9.2 meter command antenna as well as the 1.8 meter beacon antennas.

## 1.0 Background

The following analysis demonstrates that the Jupiter 107W command and beacon carriers comply with §25.138(a) of the FCC's Rules under normal operational conditions at least up to 9.23 degrees. The beacon carriers will always be operated in a manner compliant with §25.138(a); the command carriers will be fully compliant with the rule during routine on-station operations.

Section 25.138(a)(1) requires that earth stations transmitting in the frequency bands listed above do not exceed a co-polarized off-axis EIRP density of:

| | |
|---|---|
| $18.5 - 25 \log (\theta)$ dBW/40 kHz | (for $2 \leq \theta \leq 7$) |
| -2.63 dBW/40 kHz | (for $7 \leq \theta \leq 9.23$) |

Section 25.138(a)(2) requires that earth stations transmitting in the frequency bands listed above do not exceed, for angles of greater than 3 degrees from the GSO arc, a co-polarized off-axis EIRP density of:

| | |
|---|---|
| $21.5 - 25 \log (\theta)$ dBW/40 kHz | (for $3.5 \leq \theta \leq 7$) |
| 0.37 dBW/40 kHz | (for $7 \leq \theta \leq 9.23$) |

Section 25.138(a)(4) requires that earth stations transmitting in the frequency bands listed above 29.500-30.000 GHz do not exceed a cross-polarized off-axis EIRP density of:

| | |
|---|---|
| $8.5 - 25 \log (\theta)$ dBW/40 kHz | (for $2 \leq \theta \leq 7$) |
| +12.63 dBW/40 kHz | (for $7 \leq \theta \leq 9.23$) |

where $\theta$ is the angle between the earth station boresight and an adjacent satellite on the geostationary arc. In the following analysis, the command carriers and the beacon carriers are treated separately.

## 2.0 TT&C Antenna

Command and ranging carriers are used by the spacecraft operator to send commands to the spacecraft that are necessary for its continuing correct operation. Once the satellite is on-station at 107.1° WL, Hughes intends to command the Jupiter 107W spacecraft with a single command carrier operating at approximately 28,351 MHz.

As is typical for most spacecraft, a narrow-band frequency modulated (FM) carrier is used to transmit commands and ranging signals. FM has the advantage of a proven spacecraft command receiver design, demonstrated robustness to interference, and use of an existing infrastructure of TT&C stations in the United States and around the world. The Jupiter 107W command carriers are represented by the 1M00F2D emission code. For narrow-band FM carriers, the power spectral density is assumed to be constant across the necessary bandwidth.

Command carriers will be transmitted from either of two TT&C earth stations (one in each beam) to be located in the western continental United States. Each site will use a GD Satcom 9.2 meter Ka band earth station antenna to transmit commands to Jupiter 107W. This earth station antenna has a boresight transmit gain of 66.3 dBi and is designed meet the antenna off-axis gain mask specified in §25.209.

## 2.1 On-Station Operations: Command Carriers

In order to achieve the necessary on-station EIRP of 69.7 dBW, the power at the flange of the antenna is of:

$$\mathbf{EIRP_{on\text{-}axis}} = \mathbf{G_{TX\text{-}Boresight}} + \mathbf{P}$$

where:

**$G_{TX\text{-}Boresight}$:** TT&C earth station antenna gain (66.3 dBi)

**P:** Power at the earth station antenna transmit flange

Giving:

$$69.7 = 66.3 + \mathbf{P}$$

$\mathbf{P}$ = 3.4 dBW = 2.2 Watts.

Since the carrier has an occupied bandwidth of 1 MHz and the reference bandwidth is of 40 kHz:

$$\mathbf{P_{40\ kHz}} = \mathbf{P} - 10 \log [1\ \text{MHz}/40\ \text{kHz}]$$

$$\mathbf{P_{40kHz}} = 3.4\ \text{dBW} - 14\ \text{dB}$$

$$= -10.6\ \text{dBW}/40\ \text{kHz}$$

To find the off-axis EIRP density in 40 kHz.

$$\textbf{EIRP density}_{\textbf{off-axis}} = \textbf{G}_{\textbf{TX-off axis}} + \textbf{P}$$

where:

**$G_{TX\text{-}off\ axis}$:** Complies with FCC 25.209

**P:** = -10.6 dBW/40 kHz (from above)

Combining the off axis antenna gain mask as described in §§ 25.209 (a), (b) and (d) of the FCC's rules with a flange power density of -10.6 dBW/40 kHz will just meet the off-axis EIRP requirements listed in page 1 above.

## 3.0 Beacon Station

The three beacon stations transmit an unmodulated carrier that will be used by the spacecraft to maintain the accurate pointing of the narrow beams generated by the satellite antenna system. Once the satellite is on-station at 107.1° WL, Hughes intends to transmit the beacon signals toward the satellite at 29,998 MHz.

The EIRP required for this signal is of 63 dBW. The 1.8 meter earth station antenna has a boresight transmit gain of 52.4 dBi and is designed meet the antenna off-axis gain mask specified in §25.209.

## 3.1 On-Station Operations: Command Carriers

In order to achieve the necessary on-station EIRP of 63.0 dBW, the power at the flange of the antenna is of:

$$\textbf{EIRP}_{\textbf{on-axis}} = \textbf{G}_{\textbf{TX-Boresight}} + \textbf{P}$$

where:

**$G_{TX\text{-}Boresight}$:** TT&C earth station antenna gain (66.3 dBi)

**P:** Power at the earth station antenna transmit flange

Giving:

$63.0 = 52.4 + \mathbf{P}$

$\mathbf{P}$ = 10.6 dBW = 11.3 Watts.

Since the carrier has no occupied bandwidth, the power is entirely contained in the reference bandwidth of 40 kHz:

$\mathbf{P_{40\ kHz}}$ = 10.6 dBW/40 kHz

To find the off-axis EIRP density in 40 kHz.

$$\mathbf{EIRP\ density_{off\text{-}axis}} = \mathbf{G_{TX\text{-}off\ axis}} + \mathbf{P}$$

where:

**$G_{TX\text{-}off\ axis}$:** Complies with FCC 25.209

**P:** = 10.6 dBW/40 kHz (from above)

Combining the off axis antenna gain mask as described in FCC 25.209 (a), (b) and (d) with a flange power density of 10.6 dBW/40 kHz will exceed the off-axis EIRP requirements listed in page 1 above by as much as 21.2 dB. As such, coordination of the carrier is being undertaken with the operators of the satellites within 6 degrees of Jupiter 107W (Telesat Canada, DirecTV and SES).