

DESCRIPTION OF PROGRAM OF EXPERIMENTATION

In this application, Ball Aerospace & Technologies Corp. (BATC) requests authorization to establish a two-year program of research and experimentation that utilizes three (3) individual devices that re-radiate signals received from the satellites of the Global Positioning System (GPS) and augmentations, and three (3) individual devices that radiate simulated GPS signals. Either re-radiation or simulated GPS signals may be used for each location, but never at the same time.

BATC manufactures Low Earth Orbiting spacecraft for both government and commercial markets. The BATC manufactured spacecraft employ vendor purchased GPS antennas and receivers for flight attitude and control. Re-radiation of GPS signals under a strictly controlled environment is used to verify operation of the spacecraft antennas and receivers within the spacecraft system. Radiation of 'simulated' GPS signals under a strictly controlled environment from a simulator is employed to simulate spacecraft flight in order to verify flight attitude and control.

NTIA Criterion No. 1: Individual authorization is necessary for each device at a site-specific location:

BATC proposes to install three (3) fixed indoor location re-radiation devices for which it presently seeks authorizations for two buildings (FT and FA) within the Fisher Complex of the Ball Aerospace & Technologies Corp. Boulder, Colorado campus. The buildings in question is used exclusively for BATC operations in assembly and test of space systems. The zone of potential interference from the proposed fixed indoor location GPS re-radiation devices is limited to BATC property. The locations and description of the devices are as follows:

<u>XT Station Location</u>	<u>User</u>	<u>Latitude</u>	<u>Longitude</u>
1. 1600 Commerce Street FT Building	BATC	40 deg 01'01"	105 deg 13'57"
2. 1600 Commerce Street FA Building - FA Clean room	BATC	40 deg 01'06"	105 deg 14'04"
3. 1600 Commerce Street FA Building - FA Annex Clean room	BATC	40 deg 01'06"	105 deg 14'03"

See attachment 1 of this exhibit for the BATC re-radiation network.
See attachment 2 of this exhibit for the BATC Boulder campus site map.
See attachment 3 of this exhibit for GPS constellation simulator specification.

NTIA Criterion No 2: Application for frequency assignment should be applied for as an XT station with a note indicating that the device is to be used as an "Experimental RNSS Test Device for the purpose of testing stand-alone GPS receivers or GPS receivers that are an integral component of an equipment under test".

BATC shall strictly limit the use of the GPS re-radiation network to testing of GPS antennas and receiver installed on BATC manufactured spacecraft.

NTIA Criterion No. 3: Approved applications for frequency assignments will be entered in the GMF.

The frequency assignments for each of the three (3) proposed fixed indoor location GPS signal re-radiation devices is at the GPS L1-band center frequency of 1575.42 MHz and the GPS L2 band at the center frequency at 1227.6 MHz.

NTIA Criterion No. 4: The maximum length of the assignment will be two years, with possible renewal.

BATC requests authorizations with a license term of two years, with the possibility of renewal.

NTIA Criterion No. 5: The operation must be at a specified fixed location with mobil operation is not authorized.

The locations of the three (3) GPS re-radiation devices proposed by BATC are fixed at the specific indoor locations identified in No. 1 above. The BATC Boulder Colorado site map is provided as attachment 2 for reference.

NTIA Criterion No. 6: The area of potential interference to GPS reception (e.g. military or contractor facility) has to be under control of the user.

Access to the BATC facility is strictly controlled both at building and cleanroom entry. The outside property is not strictly controlled. The minimum measured distance from the building exterior walls to the BATC appropriate property boundary are as follows:

South FT building exterior wall to property boundary = 13.8 meters

West FA building exterior wall to side walk = 13.5 meters

Calculations of maximum equivalent isotropic radiated power at these boundaries is included within criterion No. 8 response following.

NTIA Criterion No. 7: The maximum equivalent isotropic radiated power must be such that the calculated emissions are no greater than -140 dBm/24 MHz at a distance of 100 feet (30 meters) from the building where the test is being conducted. The calculations showing compliance with this requirement must be provided with the application for frequency assignment and should be based on free space propagation with no allowance for building attenuation.

Attachment No. 2 of this exhibit identifies the GPS radiation network employed at the three (3) locations. Each setup illustrates that no additional amplification is employed except via the receive antenna/LAN assembly and the re-radiation antenna.

	<u>FA BLDG</u>		<u>FT BLDG</u>	
	L1	L2	L1	L2
Received Power	-128.5 dBm	-130 dBm	-128.5 dBm	-130 dBm
LNA1 Gain	+48 dB	+48 dB	+48 dB	+48 dB
Distribution Network Minimum loss	-12 dB	-12 dB	-23 dB	-23 dB
Antennuator	-10 dB	-10 dB	NA	NA
Re-rad Anttena	+4 dB	+4 dB	+4 dB	+4 dB
Total Distribution Network Change	+30 dB	+30 dB	+29 dB	+29 dB
Maximum Re-rad Signal Strength	-98.5dBm	-100dBm	-99.5dBm	-101dBm

The maximum re-radiated GPS signals shall be -98.5 dBm and -100 dBm for L1 and L2 respectively at all locations. Calculated power based on the standard path loss equation for the L1 and L2 wavelengths at 30 meters are shown following:

Calculation of power level at 30 meters

Band	L1	L2
Maximum Radiated Power	-98.5 dBm	-100 dBm
Path Loss at 30 meters	-65.9 dB	-63.8 dB
Power level at 30 meters	-164.4 dBm	-163.8 dBm

Calculations are based on free space propagation with no building attenuation, and demonstrate BATC's compliance with NTIA Criterion No. 7.

NTIA Criterion No. 8: GPS users in the area of potential interference to GPS reception must be notified that GPS information may be impacted for periods of time.

BATC shall post signs in the specific immediate zones within the facilities.

No potential GPS reception interference shall occur outside of the BATC Boulder campus property. Calculated power based on the standard path loss equation with no building attenuation for the L1 and L2 wavelengths at 13.5 meters are shown following:

Calculation of power level at 13.5 meters

Band	L1	L2
Maximum Radiated Power	-98.5 dBm	-100 dBm
Path Loss at 30 meters	-59.03 dB	-56.86 dB
Power level at 30 meters	-157.53 dBm	-156.86 dBm

Calculations indicate that maximum signal levels at the BATC property boundary are well below -140 dBm.

However, outside property is not strictly controlled. Therefore, BATC shall post notification signs of possible GPS interference.

NTIA Criterion No. 9: The use is limited to activity for the purpose of testing RNSS equipment/systems.

BATC shall strictly limit the use of the fixed indoor location GPS re-radiation devices it proposes here to verification of spacecraft systems GPS antennas and receiver operation.

NTIA Criterion No. 10: A "Stop Buzzer" point of contact for the authorized device must be identified and available at all time during GPS re-radiation operation of the device under any condition.

All test operations which involve GPS signal re-radiation shall be conducted and under control of a test engineer who can immediately terminate the GPS re-radiated signal upon notification.