In connection with this renewal application, the following is noted:

- 1. Attached hereto are the licensee's calculations demonstrating compliance with NTIA GPS Re-Radiation Criteria Section 8.3.28 of NTIA Regulations Maximum Equivalent Isotropically Radiated Power.
- 2. Location No. 1 on the existing Station WE2XXG license (Nashua (HILLSBOROUGH), NH NL 42-42-14; WL 71-26-46) is no longer being operated. Therefore, upon grant of this renewal application, it is requested that Location No. 1 be deleted from the license.
- 3. Please note the following current Stop Buzzer information for the remaining location. Upon grant of this renewal application, it is requested that Special Condition No. 7 on the license be updated to reflect this new Stop Buzzer information:
 - Hudson (HILLSBOROUGH), NH NL 42-42-09; WL 71-25-52

Primary Stop Buzzers:

John Allen (for Distribution Network A): 603-885-2084

Scott Sahlin (for Distribution Network B): 603-885-8262

Secondary Stop Buzzer:

BAE Systems Emergency Services Center, 603-885-3842 (for both networks)

- 4. A separate modification application is being filed to reflect:
 - Incorporation of additional transmitting equipment into the permanent license file, pursuant to Section 5.77(b)
 - Deletion of Location No. 1 on the existing Station WE2XXG license (Nashua (HILLSBOROUGH), NH NL 42-42-14; WL 71-26-46)
 - The new Stop Buzzer information for the remaining Hudson, NH location

Compliance with NTIA GPS Re-Radiation Criteria – Section 8.3.28 of NTIA Regulations Maximum Equivalent Isotropically Radiated Power

Two distribution networks are used to re-radiate the GPS L1 (1575.42 MHz) and L2 (1227.60 MHz) signals at several locations inside the building designated PTP02 located at NL 42-42-09, WL 71-25-52. These systems (dual band) are configured similarly with an active receiving antenna, a signal-boost amplifier (where necessary), a leveling amplifier, RF distribution network and a re-radiating antenna for both frequencies at several locations within the building site.

Calculations are performed based on Section 8.3.28 of the NTIA regulations¹, wherein item f states:

"The equivalent isotropically radiated power (EIRP) must be such that the emissions are no greater than -140dBm/24 MHz as received by an isotropic antenna at a distance of 100 feet (30 meters) from the building where the test is being conducted. The calculation for maximum EIRP shall be based on free space propagation with no allowance for additional attenuation (e.g., building attenuation) as shown below.

$$P_{T \max} = P_R + 20 \log_{10} f + 20 \log_{10} (30+d) - 27.55$$

Where: PT_{max} is the maximum permissible EIRP in dBm PR is the power received at 30 meters from the building (i.e. -140 dBm/24 MHz) f is frequency in MHz (i.e. 1575.42 for L1, 1227.60 for L2, 1176.45 for L5) d is the distance between the radiator and the closest exterior wall of the building in meters.

 $P_{T_{\text{max}}}$ can then be converted to picowatts by using the formula: $P_{T_{\text{max}}}(p_{\text{W}})=10^{((P_{T_{\text{max}}}/10)+9)}$

Applications requesting power greater than the *PT* max calculated at *d*=0 meters (i.e. 39.3 pW for L1, 23.8 pW for L2, and 21.9 pW for L5) must provide the distance from the transmit antenna to the nearest exterior wall so that reviewing agencies can determine if the requested power meets the maximum EIRP described above."

For this application, distance to the nearest exterior wall is assumed to be zero. Calculating the maximum transmit power:

L1
$$P_{T\max(dBm)} = -140 + 20\log_{10}(1575.42) + 20\log_{10}(30) - 27.55 = -74.1 \text{ dBm}$$

L1 $P_{T\max(pW)} = 10^{(-74.1/10)} + 9 = 39.3 \text{ pW}$

L2
$$P_{T \max(dBm)} = -140 + 20 \log_{10}(1227.6) + 20 \log_{10}(30) - 27.55 = -76.2 \text{ dBm}$$

L2 $P_{T \max(pW)} = 10^{(-76.2/10)} + 9 = 23.8 \text{ pW}$

¹ See *Manual of Regulations and Procedures for Federal Radio Frequency Management* Para 8.3.28 (May 2013 Edition, Rev Sept 2015).

The two distribution networks are designated Distribution Network A (with 5 re-radiating nodes) and Distribution Network B (with 1 re-radiating node). The GPS re-radiator signal strength calculations for each re-radiator follows:

The Distribution Network A path names are Star Lab Path, Eng Lab Path, AIM Factory Path, BTW Chamber Path, and Chamber 10 Path.

Note that for Distribution Network A, the amplified received signal from the roof-mounted antenna is connected to a Leveling Amp which is set to provide -77 dBm output signal for input signals within the range -115 to -85 dBm. Therefore, -77 dBm is used as the starting point for the calculations.

Distribution Network A - Star Lab	Path						
Component	"	Signal Level L2 (1227.6 MHz)			Manufacturer	Part Number	Notes
GPS Signal Input (Pr)	-130	-130	dBm	(typical)			-110 to -149 dBm (-130 dBm typical)
Antenna Gain (Gr)	7.7	4.7	dBi		Antcom	123GM1215A4-XN-1	
RX Antenna LNA (G Ina)	40	40	dB	(typical)			
Cable Loss, 100 ft (Lc1)	-25.5	-21.5	dB			RG58	-25.5dB/100ft [L1], -21.5dB/100 ft [L2]
Leveling Amp Output Level (Ps)	-77	-77	dBm	set value	GPS Source	GLI-METRO	Automatic Level Control Set to -77 dBm
Amplifier (Ga1)	16.4	17.9	dB	(typical)	Mini Circuits	ZX60-33LN	
Power Divider Loss (Ld1)	-9.7	-9.6	dB		Mini Circuits	ZN8PD1-53+	8-way Splitter
Amplifier (Ga2)	28	28	dB		Tallysman	32-0125B-00	
Cable Loss, 340 ft (Lc2)	-44.9	-39.8	dB			LMR-200	-13.2dB/100ft [L1], -11.7dB/100 ft [L2]
Re-Radiating Antenna (Gt)	3.0	3.0	dBi		Antcom	2.3G1215P-XRS-4	
GPS Transmit Power	-84.18	-77.48	dBm				
GPS Transmit Power	3.82	17.86	pW				
Path Loss at 100 ft (Lfs)	-66.1	-63.9	dB				Assume 0 ft distance from antenna to bldg wall
EIRP @ 100 ft from Bldg (Psig)	-150.28	-141.38	dBm/24 MHz				
Psig (EIRP) = Ps + Ga1 + Ld1 + Ga2	+ Lc2 + Gt + Lfs						

Distribution Network A - Eng Lab	Path						
Component	Signal Level L1 (1575.42 MHz)	Signal Level L2 (1227.6 MHz)			Manufacturer	Part Number	Notes
GPS Signal Input (Pr)	-130	-130	dBm	(typical)			-110 to -149 dBm (-130 dBm typical)
Antenna Gain (Gr)	7.7	4.7	dBi		Antcom	123GM1215A4-XN-1	
RX Antenna LNA (G Ina)	40	40	dB	(typical)			
Cable Loss, 100 ft (Lc1)	-25.5	-21.5	dB			RG58	-25.5dB/100ft [L1], -21.5dB/100 ft [L2]
Leveling Amp Output Level (Ps)	-77	-77	dBm	set value	GPS Source	GLI-METRO	Automatic Level Control Set to -77 dBm
Amplifier (Ga1)	16.4	17.9	dB	(typical)	Mini Circuits	ZX60-33LN	
Power Divider Loss (Ld1)	-9.7	-9.6	dB		Mini Circuits	ZN8PD1-53+	8-way Splitter
Attenuator (Latten)	-10	-10	dB		Mini Circuits	BW-S10W2+	
Cable Loss, 24 ft (Lc2)	-3.2	-2.8	dB			LMR-200	-13.2dB/100ft [L1], -11.7dB/100 ft [L2]
Re-Radiating Antenna (Gt)	3.0	3.0	dBi		Antcom	2.3G1215P-XRS-4	
GPS Transmit Power	-80.5	-78.5	dBm				
GPS Transmit Power	8.91	14.13	pW				
Path Loss at 100 ft (Lfs)	-66.1	-63.9	dB				Assume 0 ft distance from antenna to bldg wall
EIRP @ 100 ft from Bldg (Psig)	-146.6	-142.4	dBm/24 MHz				
Psig (EIRP) = Ps + Ga1 + Ld1 + Latt	en + Lc2 + Gt + Lfs						

						I DAILING!	Distribution Network A - BTW Cha
						Joquic	dayler A souton noithdistin
						517 + 30	. 777 . 777 . 770 . 51 - / 1717) 915 1
						211+19	+ Co1 + Lb1 + Ga1 + Ld1 + Lc2 +
				ZHM 42/m8b	5.141.3	9.941-	(gizq) gbl8 mort ft 001 @ 9819
llew gbld ot ennetne mort eonetsib ft 0 emussA				Вb	6.68-	T.89-	Path Loss at 100 ft (Lfs)
				Wq	18.20	16.8	GPS Transmit Power
				mab	₽. ۲ ۲ -	2.08-	GPS Transmit Power
	2.3G1215P-XRS-4	moɔtnA		iab	0.8	0.8	(12) ennetnA gnitsibsA-9A
[L1] # 001/8b/.11 [L1] +1001/8b/.201	LMR-200			8p	7.11.	Z.£1-	Cable Loss, 100 ft (Lc2)
8-way Splitter	ZN8bDT-23+	Mini Circuits		8b	9.6-	L'6-	Power Divider Loss (Ld1)
	NJEE-09XZ	Mini Circuits	(typical)	Вb	6.7 <u>1</u>	7°'9T	Amplifier (Ga1)
MBb TT- of 192 lontro) Level Centro	GLI-METRO	GPS Source	set value	mab	LL-	LL-	(Ps) level tuqtuO qmA gnilevel
[L1] # 001/8b2.11-, -21.5d8/100 ft	RG58			8p	5,12-	5.25-	Cable Loss, 100 ft (Lc1)
			(typical)	Вb	0t⁄	0t⁄	(anl D) AMJ ennetnA X8
	123GM1215A4-XN-1	moɔtnA		iab	L. A	L.T	Antenna Gain (Gr)
(lesiqy1 m8b 0£1-) m8b 041- of 011-			(typical)	mab	0ET-	0ετ-	GPS Signal Input (Pr)
Notes	Part Number	Manufacturer			SJ level Langič (zHM 8.7SSL)	£1 ləvəl langi? (sHM S4.272£)	10000000
						ф	Distribution Network A - AIM Fac

Notes	Part Number	Manufacturer			SJ level Langið (zHM 8.72S1)		Component
110 to -149 dBm (-130 dBm typical)			(typical)	mab	-130	-130	GPS Signal Input (Pr)
	123GM1215A4-XN-1	moɔfnA		iab	L. A.	T.T	(Gr) (Gr)
			(typical)	8b	01⁄2	01⁄2	(6 Ina) AMJ ennetnA XA
[L2] # 001/8b2.15- ,[L1] #001/8b2.25-	RG58			8p	2,12-	2.25.5	Cable Loss, 100 ft (Lc1)
Mab TT- of 192 lortno level Centrol Set to	GLI-METRO	GPS Source	eulev fes	mab	LL-	LL-	(29) level tuqtuO qmA gnilevel
	N7EE-09XZ	Mini Circuits	(typical)	8p	6.7 <u>1</u>	16.4	(L69) 19ifilqmA
8-way Splitter	ZN8bDT-23+	Mini Circuits		8b	9.6-	۷.6-	Power Divider Loss (Ld1)
[13.2dB/100f [L1], -11.7dB/100 ft [L2]	LMR-200					7.51-	Cable Loss, 80 ft (Lc2)
Z-way Splitter	ZAPD-2-S+	Mini Circuits				2.8-	Power Divider Loss (Ld2)
-13.2dB/100f [L1], -11.7dB/100 ft [L2]	LMR-200			ВÞ		£.T-	Cable Loss, 55 ft (Lc3)
	2.3G1215P-XRS-4	moɔtnA		iab	3.0	3.0	(10) ennetnA gniteibeA-9A
				mab	1.78-	T6-	GPS Transmit Power
				Wq	S6'T	6 7 .0	SPS Transmit Power
lew gbld of ennetne mort eonsteib ft 0 emussA				8b	6.68-	T.99-	Path Loss at 100 ft (Lfs)
				zHM 42/m8b	TST-	T'ZST-	(Biz9) Bbl8 morf ff 00 L @ 9819
					21	1+12+521+5b1	+ CoJ + LbJ + L63 + 29 = (9813) gi29

					2ª	1 + 19 + E27 + CF + F	Psig (EIRP) = Ps + Ga1 + Ld1 + Lc2 +
				ZHM 4Z/m8b	TST-	1.721-	EIRP @ 100 ft from Bldg (Psig)
Ilsw gbld of snnefns mort eanstsib ft 0 emussA				Вb	6.63-	T'99-	Path Loss at 100 ft (Lfs)
						6Z.0	GPS Transmit Power
				mab	1.78-	16-	Tewor Jimzner CPO
	W1118.05.2T	Taoglas		iab	0.8	0.8	(t2) ennetnA gniteibeA-eA
-13.2dB/100f [L1], -11.7dB/100 ft [L2]	LMR-200			Вb	c.a-	£. 7 -	Cable Loss, 55 ft (Lc3)
8-way Splitter	-S-S-G9AZ	Mini Circuits		Вb	2.8-	2.8-	Power Divider Loss (Ld2)
[LZ] # 001/8b/.11- ,[L1] #001/8b2.51-	LMR-200			Вb	L'TT-	2.81-	Cable Loss, 80 ft (Lc2)
	ZN8bDT-23+	Mini Circuits		Вb	9.6-	7. 6-	Power Divider Loss (Ld1)
	N7EE-09XZ	Mini Circuits	(typical)	Вb	6.7 <u>1</u>	7°9T	Amplifier (Ga1)
MBb TT- of 192 lontro) Level Centro	GLI-METRO	GPS Source	eulev tes	mab	LL-	LL-	(29) level tuqtuO qmA gnilevel
[LZ] # 001/8b2.tz- (L1] #001/8b2.22-	RG58			Вb	S'TZ-	5.25.5	Cable Loss, 100 ft (Lc1)
			(typical)	Вb	01⁄2	01⁄2	(6nl D) AVJ ennetnA XA
	123GM1215A4-XN-1	moɔtnA		iab	L. A	L.T	Antenna Gain (Gr)
(lesiqy1 m8b 0£1-) m8b 041- of 011-			(typical)	mab	0ET-	0ET-	GPS Signal Input (Pr)
Notes	Part Number	Manufacturer			SJ level Langi? (zHM 8.7SS1)	£1 ləvəl langi? (xHM £4.272£)	Component
						01.10	Distribution Network A - Chambe

The only path in Distribution Network B is named Production Lab Path.

Component	Signal Level L1 (1575.42 MHz)	Signal Level L2 (1227.6 MHz)			Manufacturer	Part Number	Notes
GPS Signal Input (Pr)	-130	-130	dBm	(typical)			-110 to -149 dBm (-130 dBm typical)
Antenna Gain (Gr)	3	3	dBi		GPS Source	L1L2-2GA-PM-NF	
RX Antenna LNA (G Ina)	33	33	dB	(typical)			
Cable Loss, 100 ft (Lc1)	-10.2	-9	dB			LMR240	-10.2dB/100ft [L1], -9dB/100 ft [L2]
16-way Splitter, Active (Gsp)	8	8	dB	(typical)	GPS Source	RMS116-A08-P110/5-NF	16-way Splitter
Cable Loss, 100 ft (Lc2)	-10.2	-9	dB			LMR240	-10.2dB/100ft [L1], -9dB/100 ft [L2]
Amplifier (Ga1)	30	30	dB	(typical)	GPS Source	A11-P110/5-NF	
Attenuator (Latten)	-10	-10	dB		MiniCircuits	15542	
Re-Radiating Antenna (Gt)	3.0	3.0	dBi		GPS Source	L1L2-2GP	
GPS Transmit Power	-83.4	-81	dBm				
GPS Transmit Power	4.57	7.94	pW				
Path Loss at 100 ft (Lfs)	-66.1	-63.9	dB				Assume 0 ft distance from antenna to bldg wall
EIRP @ 100 ft from Bldg (Psig)	-149.5	-144.9	dBm/24 MHz				