NARRATIVE DESCRIPTION

Pursuant to Sections 5.54 and 5.61 of the rules of the Federal Communication Commission (the "FCC" or "Commission"),[1] KeyW Corporation ("KeyW") respectfully requests experimental special temporary authorization ("STA") for a period of six (6) months to test and evaluate its phased array antenna (the "KeyW Experimental Payload") by, among other things, transmitting in the 8025-8325 MHz (space-to-Earth) band. KeyW also seeks authority to operate a 1.5m tracking earth station antenna (the "KeyW Experimental Earth Station") at a University of Arizona facility in Tucson, Arizona[2] to transmit signals to the KeyW Experimental Payload in the 8450-9000 MHz, 9200-10550 MHz , and 11.7-12.2 GHz (Earth-to-space) bands.

The proposed operations are an extension of KeyW's existing experimental STA operations pursuant to Call Sign WO9XIO, which include experimental ground-to-air transmissions from KeyW's facility near Baltimore Washington International airport.[3] KeyW's existing experimental operations have not caused any interference incidents and its newly proposed operations, with the additional interference measure described herein, are even less likely to do so. The experimental operations proposed herein will be conducted in a more limited in frequency range, at lower power, with a more directional (higher gain) antenna, and in a more remote location. Accordingly, the potential for interference associated with the operations should be significantly lower.

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[1] 47 C.F.R. §§ 5.54(a)(2) & 5.61.

[2] Geographic coordinates: 32° 05' 22.8" N, 110° 48' 33.1" W.

[3] *See* KeyW Corporation, File No. 0537-EX-ST-2019, Call Sign WO9XIO ("*KeyW Experimental STA*") (authorizing KeyW to conduct, among other things, experimental ground-to-air operations in portions of the 8.45-12.0 GHz bands in support of similar U.S. government operations).

KeyW respectfully requests expedited consideration and grant of this STA request by December 31, 2019, and earlier if possible, with commencement of operations on or about May 1, 2020.[4] The KeyW Experimental Payload will be a hosted payload on a non-geostationary satellite orbit ("NGSO") cubesat – a LEMUR-2 satellite operated by Spire Global, Inc. ("Spire")[5] – which is scheduled to launch late in Q1 2020. As described herein and other materials submitted with this application,[6] grant of the requested experimental STA request would strongly serve the public interest.

I. DISCUSSION

KeyW provides diverse technology and cybersecurity solutions for government and commercial customers. The proposed experimental operations are an extension of the existing *KeyW Experimental STA* operations and will allow KeyW to test key technical features of its antenna technology in a true space-based environment. The KeyW Experimental Payload was specifically designed to operate on Spire's LEMUR-2 satellite to facilitate evaluation of the on-orbit characteristics of KeyW's antenna. Experimental payload communications will commence as soon as possible after May 1, 2020, following the LEMUR-2 satellite's deployment from the International Space Station ("ISS"). To the extent applicable, KeyW incorporates by reference

[4] It is possible that the KeyW Experimental Payload mission could extend beyond the initial six-month STA period. Should circumstances warrant additional testing, demonstration, and data collection, KeyW will file a subsequent six-month experimental STA request to cover extended experimental operations.

[5] The LEMUR-2 satellite model has been previously authorized for commercial operation by the Commission. Spire has separately filed an experimental STA request to support this testing and demonstration mission. *See* Spire Global, Inc., File Nos. SAT-LOA-20151123-00078 & SAT-AMD-20180102-00001, Call Sign S2946, granted on Nov. 29, 2018 ("*Spire License*"); *see also* Spire Global, Inc., File No. 1228-EX-ST-2019 ("*Spire Experimental STA*").

[6] *See, e.g.*, FCC Form 442, Technical Appendix and Confidential Exhibit 1. Due to the highly sensitive nature and security implications of the proposed operations, KeyW requests that Exhibit 1 be treated as confidential. *See* Confidential Treatment Request and Exhibit 1.

the spacecraft technical data, orbital characteristics, and related information provided in the *Spire License* and *Spire Experimental STA* applications.[7] Thus, this STA request focuses on information related to the KeyW Experimental Payload and KeyW Experimental Earth Station only.

A. The KeyW Experimental Payload

The KeyW Experimental Payload is a steerable, transmit-receive phased array antenna. Payload downlink (earth station receive) operations will be conducted in portions of the 8025-8325 MHz band, which is consistent with the downlink authorization in the *Spire License*. Payload transmissions will be conducted using two modes: communications mode (using a traditional modulating carrier (QPSK)) and "chirp" mode (*i.e.*, a swept gaussian modulated sinusoidal waveform). During the term of this experimental STA, the KeyW Experimental Payload will operate intermittently and on an as-needed basis to conduct experimental downlink transmissions during approximately one pass per day (approximately 6-8 minutes per pass) to the KeyW Experimental Earth Station in Tucson, Arizona.

KeyW's temporary experimental operations have no regulatory status vis-à-vis other authorized users of the band and KeyW is working with U.S. government agencies to ensure its proposed experimental downlink operations do not cause interference to U.S. government operations. In particular, KeyW has commenced discussions with NASA to ensure its ground station operations do not cause interference to U.S. government facilities in the southwestern United States. KeyW is also pursuing discussions with other U.S. government agencies and will adhere to any specific conditions or spectrum exclusions in the proposed downlink band.

[7] *See Spire License* and *Spire Experimental STA*.

B. The KeyW Experimental Earth Station

In addition to receiving transmissions from the KeyW Experimental Payload to evaluate its transmit capabilities, a primary purpose of the KeyW Experimental Earth Station is to transmit to the payload to test the phased array antenna's performance. Because KeyW will operate the KeyW Experimental Earth Station at lower power levels than those authorized in the *KeyW Experimental STA,* the newly proposed uplink operations will be less interfering than those previously conducted by KeyW without interference incident.

The basic operational characteristics of the KeyW Experimental Earth Station are set forth in Table 2, below, and the antenna gain pattern is included in Figure 2, below.

Table 1. KeyW Experimental Earth Station Characteristics

Characteristic	**Description**
Antenna Type	Mechanically steered, parabolic tracking antenna
Antenna Size	1.5m (General Dynamics reflector)
Antenna Gain	40.2 dBi (8725 MHz), 41.2 dBi (9875 MHz) and 42.9 dBi (11950 MHz)
Antenna Orientation	Satellite Nadir
Half-Power Beamwidth	1.7° (87(25 MHz), 1.5° (9875 MHz), 1.2° (11950 MHz) (limited roll-off beyond 20° off boresite)
Tracking Rate	12°/sec azimuth; 7°/sec elevation (max)

Additional information regarding the KeyW Experimental Earth Station is provided in the attached Technical Appendix.

The 8450-9000 MHz band is allocated on a primary basis for space research operations (space-to-Earth) (*i.e.*, the opposite direction of transmission proposed by KeyW) and the 9200-10550 MHz band has various allocations for non-Federal uses, including a secondary allocation for radiolocation operations. The KeyW Experimental Earth Station will track the satellite (and payload) as it passes over the site and will transmit and receive intermittently for brief periods while the satellite is in view (one pass per day for approximately 6-8 minutes), and will not

operate below a minimum elevation angle of 10 degrees (or such other minimum elevation angle at azimuth as may be agreed with U.S. government representatives).

There are two FCC-licensed operators in the 9200-10550 MHz band within a 50-mile radius of the proposed KeyW Experimental Earth Station site: Trimble Inc., Call Sign WQLP914 (located approximately 25.8 km away), and Airobotics Inc., Call Sign WRCH844 (located approximately 62.9 km away). KeyW has contacted these potentially affected licensees and received confirmation from Airobotics Inc. that it has no concerns regarding the proposed operations. KeyW understands that a similar response from Trimble Inc. is forthcoming and will update the Commission once their response has been confirmed.

The 11.7-12.2 GHz band is the commercial, conventional Ku-band fixed-satellite service ("FSS") earth station receive band, so the only potential for interference is into Ku-band earth station receivers. However, given the Commission's longstanding precedent of authorizing experimental transmit operations in this band, and as confirmed by KeyW's own experience, the potential for interference from the requested operations is *de minimis*.

The Commission's Experimental Licensing System reveals dozens of examples of transmit operations in the 11.7-12.2 GHz band. Most recently, for example, for the fifth time since 2011, the Commission granted AT&T authority to operate a radio in this band on a terrestrial fixed service ("FS") tower in the radio-congested area of Middletown, New Jersey (a short distance from New York City).[8] Given the horizontal nature of FS transmission paths, such an application necessarily has a greater potential for interference than earth station uplink operations. The Commission has also repeatedly authorized ViaSat to conduct earth station

[8] AT&T Corp., Call Sign WF2XVG, File No. 0331-EX-CR-2019 (granted June 14, 2019).

uplink operations in this band in Duluth, Georgia.[9] KeyW itself has conducted ground-to-air operations in this band in the Baltimore-Washington metropolitan area without interference incident. Thus, similar operations can be authorized in the Tucson, Arizona region without interference concerns.

With limited exception, KeyW acknowledges and accepts the conditions included in the *KeyW Experimental STA* will be applicable to the operations proposed herein, and any such other conditions as may be appropriate for temporary operations in the Tucson, Arizona area. However, KeyW refers the Commission to Special Condition 3 of the *KeyW Experimental STA*, which provides:

> (3) Licensee must avoid pointing the transmitting antenna within 15 degrees of any point on the geostationary orbit arc while transmitting signals in the 3600-3800 MHz and 10.7-12.0 GHz bands.

KeyW notes that the bands included in the condition are satellite transmit (downlink) bands and therefore there is no potential for interference from earth station transmissions in these bands towards the GSO arc. Because KeyW seeks to maximize its one-pass-per-day operations with the KeyW Experimental Payload, it respectfully requests that the Commission refrain from including this condition in the requested experimental STA.

At all times, KeyW will adhere to its obligations under Part 5 of the Commission's rules to operate on an unprotected, non-interference basis during the term of the requested experimental STA.[10]

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[9] ViaSat, Inc., Call Sign WI2XQD, File No. 0526-EX-CR-2018 (granted Dec. 6, 2018).

[10] If KeyW learns its experimental operations are causing interference into existing spectrum users, it will immediately cease transmissions and will not resume transmissions until it establishes that further harmful interference will not be caused to any authorized radio service. *See* 47 C.F.R. § 5.84.

C. Experimental Station Control & Contact Information

As operator of the KeyW Experimental Payload and KeyW Experimental Earth Station, KeyW will have the ability to immediately cease operations as appropriate, and will cease transmission immediately in the unlikely event of harmful interference. The stop buzzer contact during experimental operations is:

Zach Baum
7736 Old Telegraph Road
Severn, MD 21144
Zachary.baum@keywcorp.com
+1.443.274.1480 (Office)
+1.318.348.5073 (Mobile)

II. PUBLIC INTEREST CONSIDERATIONS

In accordance with Section 5.63(c)(1) of the Commission's rules,[11] KeyW anticipates that its proposed experimental operations will contribute greatly to the radio art and serve the public interest. The proposed experimental antenna evaluations will help validate the capabilities of an innovative antenna technology for the benefit of the U.S. public.

III. CONCLUSION

Based on the foregoing, KeyW respectfully requests that the Commission grant this six-month experimental STA application, by December 31, 2019 (or sooner if possible), to permit the described operation of the KeyW Experimental Payload in the 8025-8325 MHz (space-to-Earth) band and the KeyW Experimental Earth Station in the 8450-9000 MHz, 9200-10550 MHz, and 11.7-12.2 GHz (Earth-to-space) bands.

[11] 47 C.F.R. § 5.63(c)(1).

KeyW Corporation
Application for Experimental Special Temporary Authorization
Technical Appendix

I. Technical Description

II. Link Budgets

III. Antenna Patterns

IV. Radiation Hazard Analysis

Technical Description

This Technical Appendix describes the key operational characteristics of the KeyW Experimental Payload and an associated 1.5m KeyW Experimental Earth Station in support of the KeyW Corporation ("KeyW") application for experimental special temporary authorization ("STA") to test and evaluate its new wideband phased array antenna technology. In addition to the attached link budgets, antenna patterns, and radiation hazard analysis (for the earth station), KeyW provides below a brief description of the proposed operating parameters.

KeyW Experimental Payload

The KeyW Experimental Payload consists of a transmit-receive phased array antenna that is capable of operating in the frequency bands identified in this experimental STA request. Additional information regarding the KeyW Experimental Payload is provided in FCC Form 442 and Confidential Exhibit 1.

KeyW Experimental Earth Station

The KeyW Experimental Earth Station consists of a commercial 1.5-meter diameter prime focus parabolic reflector manufactured by General Dynamics and fitted with a feed to cover the full range of bands for the proposed experimental operations. The earth station will be mounted on a pedestal with an azimuth and elevation gimbal located on an existing rooftop located at 9070 Rita Road in Tucson, Arizona. The pedestal height will be approximately 2 meters above the building (about 19 meters above ground level).

The KeyW Experimental Earth Station will support communication uplinks to the KeyW Experimental Payload in the 8450-9000 MHz, 9200-10550 MHz, and 11700-12200 MHz bands. The earth station will also transmit a linear FM chirp waveform using the same ERP and bandwidth as used for communications. In addition, the ground station will receive downlink communications and linear FM chirp waveforms from the satellite.

The KeyW Experimental Earth Station is fitted with a transmit power amplifier located near the feed point with an output level of about 1.6 watts (exclusive of cable losses to the feed). In addition, a transmit bandpass filter is provided to limit the out-of-band emissions from the transmitter. The earth station has uplink and downlink interfaces to an indoor unit at an intermediate frequency of less than 2 GHz using Heliax cable. Inside the indoor unit is an Ettus X310 software defined transceiver that will interface with the outdoor unit to provide the intermediate frequency to baseband signal processing. The interface between the outdoor unit and the indoor unit is at L-band, and the RF to/from the antenna to the indoor unit is frequency translated. The feed is mounted on the dish and all of the RF components are located in a weatherproof enclosure.

The KeyW Experimental Earth Station will operate simplex for each of four modes: communications transmit, communications receive, chirp transmit, and chirp receive. A switch near the feed is used to select either the transmit or receive path, and the same polarization will be used for each. Discrete local oscillators are employed near the feed to convert the signals for both.

II. Link Budgets

8.025-8.325 GHz (space-to-Earth)

Link Rate, bps	**2.50E+06**

System Parameters

Frequency, Hz	8.20E+09
Wavelength, meters	0.0366
Symbol Rate, sps	**2500000.00**
Range, km	**789.57**
Modulation Description	**QPSK**
Modulation Order, {sqrt(M-ary states)}	2
FEC Code Rate, Rc	**0.5**
Interference Level, rel dB	**-100.00**
Elevation angle at max range, deg	**12.22**
Max PFD at NADIR, dBW/m^2/4 kHz	**-142.98**

Satellite Transmitter

Gain, dBi	**15.44**
Depolarization Loss	**0.00**
Transmitter Power, dBm	**23.00**
Backoff, dB	**0.00**
Antenna Cable Loss, dB	**0.00**
Antenna Pointing Loss, dB	**0.00**
Scan Loss	**0.00**
EIRP, dBm	38.44

Gateway Receiver

Antenna Temperature, K	**50**
Gain, dBi	**39.63**
Depolarization Loss	**3.50**
Receiver Line Losses	**1.25**
Receiver Noise Bandwidth, Hz	**2.500E+06**
Noise Figure, dB	**2.40**
Pointing loss, dB	**0.50**
Scan loss, dB	**0.00**
Net Receiver gain at antenna, dB	35.63

Noise Computations

Boltzmann's Constant (k), J/K	1.38E-23
Line Loss Ratio	0.75
Ant temp	50.00
line temp ref to ant	96.72
Receiver Temp ref to ant	285.32
Background Noise	0.00
sys temp	432.04
Thermal Noise Power in Receiver, dBm	-108.27
Receiver G/T	9.77

Link

EIRP, dBm	38.44
Space loss, dB	-168.66
Net Receiver gain at antenna port, dB	35.63
Power Received, dBm	-94.59
Interference Received, dBm	-194.59
Noise plus Interference Power, dBm	-108.27
Propagation Losses, dB	0.20
Carrier to Interference + Noise (CINR), dB	13.47
Implementaton Loss, dB	2.5
Eb/No, dB	10.97
Required Eb/No, dB	1.05

Margin, dB	**9.92**

8.45-9.0 GHz (Earth-to-space)

Link Rate, bps	**2.50E+06**

System Parameters

Frequency, Hz	8.725E+09
Wavelength, meters	0.0344
Symbol Rate, sps	**2500000.00**
Range, km	**789.57**
Modulation Description	**QPSK**
Modulation Order, {sqrt(M-ary states)}	2
FEC Code Rate, Rc	**0.5**
Interference Level, rel dB	**-100.00**
Elevation angle at max range, deg	**12.22**

Gateway Transmitter

Gain, dBi	**40.17**
Depolarization Loss	**0.00**
Transmitter Power, dBm	**32.00**
Transmit Power, watts	**1.58**
Backoff, dB	**0.00**
Antenna Cable Loss, dB	**1.25**
Antenna Pointing Loss, dB	**0.00**
Scan Loss	**0.00**
EIRP, dBm	70.92
EIRP, dBW	40.92
ERP, dBW	38.77

Satellite Receiver

Antenna Temperature, K	**50**
Gain, dBi	**15.44**
Depolarization Loss	**3.50**
Receiver Line Losses	**0.75**
Receiver Noise Bandwidth, Hz	**2.500E+06**
Noise Figure, dB	**1.50**
Pointing loss, dB	**0.50**
Scan loss, dB	**0.00**
Net Receiver gain at antenna, dB	11.44

Noise Computations

Boltzmann's Constant (k), J/K	1.38E-23
Line Loss Ratio	0.84
Ant temp	290.00
line temp ref to ant	54.67
Receiver Temp ref to ant	142.19
Background Noise	0.00
sys temp	486.85
Thermal Noise Power in Receiver, dBm	-107.75
Receiver G/T	-14.93

Link

EIRP, dBm	70.92
Space loss, dB	-169.20
Net Receiver gain at antenna port, dB	11.44
Power Received, dBm	-86.84
Interference Received, dBm	-186.84
Noise plus Interference Power, dBm	-107.75
Propagation Losses, dB	0.20
Carrier to Interference + Noise (CINR), dB	20.71
Implementaton Loss, dB	2.5
Eb/No, dB	18.21
Required Eb/No, dB	1.05

Margin, dB	**17.16**

9.20-10.55 GHz (Earth-to-space)

Link Rate, bps	**2.50E+06**

System Parameters

Frequency, Hz	9.875E+09
Wavelength, meters	0.0304
Symbol Rate, sps	**2500000.00**
Range, km	**789.57**
Modulation Description	**QPSK**
Modulation Order, {sqrt(M-ary states)}	2
FEC Code Rate, Rc	**0.5**
Interference Level, rel dB	**-100.00**
Elevation angle at max range, deg	**12.22**

Gateway Transmitter

Gain, dBi	**41.24**
Depolarization Loss	**0.00**
Transmitter Power, dBm	**32.00**
Transmit Power, watts	**1.58**
Backoff, dB	**0.00**
Antenna Cable Loss, dB	**1.25**
Antenna Pointing Loss, dB	**0.00**
Scan Loss	**0.00**
EIRP, dBm	71.99
EIRP, dBW	41.99
ERP, dBW	39.84

Satellite Receiver

Antenna Temperature, K	**50**
Gain, dBi	**15.44**
Depolarization Loss	**3.50**
Receiver Line Losses	**0.75**
Receiver Noise Bandwidth, Hz	**2.500E+06**
Noise Figure, dB	**1.50**
Pointing loss, dB	**0.50**
Scan loss, dB	**0.00**
Net Receiver gain at antenna, dB	11.44

Noise Computations

Boltzmann's Constant (k), J/K	1.38E-23
Line Loss Ratio	0.84
Ant temp	290.00
line temp ref to ant	54.67
Receiver Temp ref to ant	142.19
Background Noise	0.00
sys temp	486.85
Thermal Noise Power in Receiver, dBm	-107.75
Receiver G/T	-14.93

Link

EIRP, dBm	71.99
Space loss, dB	-170.28
Net Receiver gain at antenna port, dB	11.44
Power Received, dBm	-86.85
Interference Received, dBm	-186.85
Noise plus Interference Power, dBm	-107.75
Propagation Losses, dB	0.20
Carrier to Interference + Noise (CINR), dB	20.70
Implementaton Loss, dB	2.5
Eb/No, dB	18.20
Required Eb/No, dB	1.05

Margin, dB	**17.15**

11.7-12.2 GHz (Earth-to-space)

Link Rate, bps	**2.50E+06**

System Parameters

Frequency, Hz	1.195E+10
Wavelength, meters	0.0251
Symbol Rate, sps	**2500000.00**
Range, km	**789.57**
Modulation Description	**QPSK**
Modulation Order, {sqrt(M-ary states)}	2
FEC Code Rate, Rc	**0.5**
Interference Level, rel dB	**-100.00**
Elevation angle at max range, deg	**12.22**

Gateway Transmitter

Gain, dBi	**42.90**
Depolarization Loss	**0.00**
Transmitter Power, dBm	**32.00**
Transmit Power, watts	**1.58**
Backoff, dB	**0.00**
Antenna Cable Loss, dB	**1.25**
Antenna Pointing Loss, dB	**0.00**
Scan Loss	**0.00**
EIRP, dBm	73.65
EIRP, dBW	43.65
ERP, dBW	41.50

Satellite Receiver

Antenna Temperature, K	**50**
Gain, dBi	**15.44**
Depolarization Loss	**3.50**
Receiver Line Losses	**0.75**
Receiver Noise Bandwidth, Hz	**2.500E+06**
Noise Figure, dB	**1.50**
Pointing loss, dB	**0.50**
Scan loss, dB	**0.00**
Net Receiver gain at antenna, dB	11.44

Noise Computations

Boltzmann's Constant (k), J/K	1.38E-23
Line Loss Ratio	0.84
Ant temp	290.00
line temp ref to ant	54.67
Receiver Temp ref to ant	142.19
Background Noise	0.00
sys temp	486.85
Thermal Noise Power in Receiver, dBm	-107.75
Receiver G/T	-14.93

Link

EIRP, dBm	73.65
Space loss, dB	-171.93
Net Receiver gain at antenna port, dB	11.44
Power Received, dBm	-86.84
Interference Received, dBm	-186.84
Noise plus Interference Power, dBm	-107.75
Propagation Losses, dB	0.20
Carrier to Interference + Noise (CINR), dB	20.70
Implementaton Loss, dB	2.5
Eb/No, dB	18.20
Required Eb/No, dB	1.05

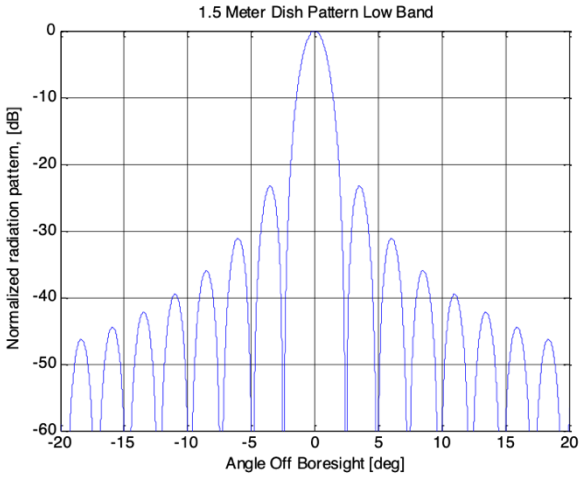
Margin, dB **17.15**

III. Antenna Patterns

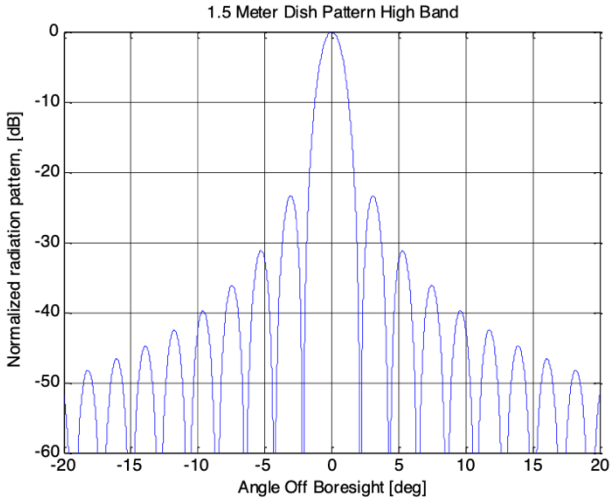
KeyW Experimental Earth Station Antenna Patterns

A cosine taper has been assumed to achieve a 1st sidelobe level of about -23 $dB_{peak.}$ The patterns do not drop significantly beyond 20 degrees off boresight.

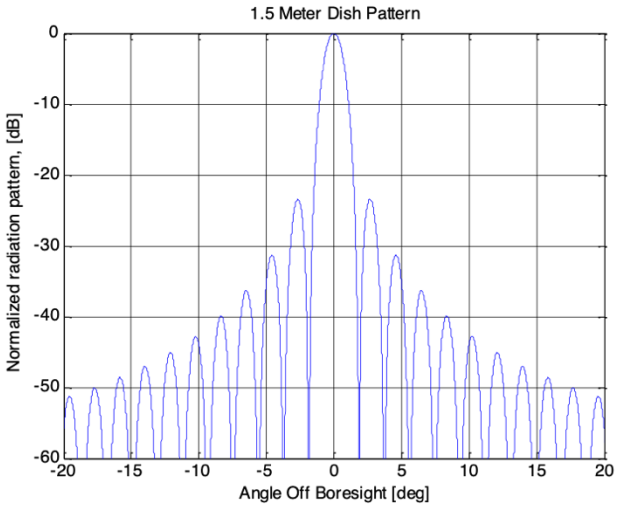
8450-9000 MHz
(Mid-band EIRP of 40.9 dBW)



9200-10550 MHz
(Mid-band EIRP of 42.0 dBW)



11700-12200 MHz
(Mid-band EIRP of 43.7 dBW)



IV. Radiation Hazard Calculations

Radiation Hazard Calculations

This report provides the non-ionizing radiation level calculations for a 1.5m ground station antenna in the 8.45-9.0 GHz, 9.20-10.55 GHz and 11.7-12.2 GHz bands. The analysis and calculations performed in this report comply with the methods described in the FCC Office of Engineering and Technology's (OET) Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields Bulletin 65, Supplement B. The radiation safety limits used in the analysis are in conformance with OET 65, Appendix A which specifies that there are two separate tiers of exposure limits that are dependent on the situation in which the exposure takes place and/or the status of the individuals who are subject to the exposure. The report below uses the worst-case scenario exposure limit for uncontrolled environments, however, at all times the 1.5m ground station will be operated in a controlled environment by trained personnel.

In the subject frequency bands, the maximum permissible exposure (MPE) level of non-ionizing radiation to which persons may be exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30-minute period in an uncontrolled (general population) environment. The purpose of this report is to show the power density levels of the earth station in the far-field, near-field and between the antenna edge and the ground (the surface) and to compare these levels to the uncontrolled MPE limits. The 1.5m ground station will operate well below the permissible levels for the general population environment and, in any event, will be located in a controlled area only accessible to qualified workers.

Table 1: Parameters and Conclusions

		Lo-band 8725 MHz	Mid-band 9875 MHz	High-band 11950 MHz
Maximum Permissible Exposure (MPE)				
Frequency	**Hz**	8725000000	9875000000	11950000000
Wavelength	**cm**	3.44	3.04	2.51
EIRP	**dBWi**	40.92	41.99	43.65
EIRP	**mW**	12359474	15812480	23173946
Transmit Power	**W**	1.58	1.58	1.58
TX GW Antenna Size	**cm**	150.00	150.00	150
Antenna Efficiency	**fraction**	0.70	0.70	0.7
R_{nf} (extent of the near field)	**cm**	1635.94	1851.56	2240.63
R_{ff} (beginning of far field)	**cm**	3926.25	4443.75	5377.50
$S_{surface}$	**mW/cm^2**	0.36	0.36	0.36
S_{nf} (maximum near field power density)	**mW/cm^2**	0.25	0.25	0.25
S_{ff} (maximum far field power density)	**mW/cm^2**	0.06	0.06	0.06
Duty Cycle	**%**	100.00	100.00	100.00
$S_{surface}$ (with Duty Cycle)	**mW/cm^2**	0.35764	0.35764	0.35764
S_{nf} (with Duty Cycle)	**mW/cm^2**	0.250347	0.250347	0.250347
S_{ff} (with Duty Cycle)	**mW/cm^2**	0.06380	0.06372	0.06377
MPE Spec (Uncontrolled Exposure)	**mW/cm^2**	1.00	1.00	1.00

Conclusion

Based upon the above analysis, it is concluded that KeyW Corporation ("KeyW") will comply with the MPE limit of 1.0 mW/cm^2 for uncontrolled (general population) environments. Nevertheless, KeyW acknowledges its responsibility to ensure that the public and operational personnel are not exposed to harmful levels of radiation, and it will take steps to mitigate any potential exposure to harmful radiation (including posting radiation hazard signage on site to inform individuals in the area that they are close to a RF antenna capable of producing hazardous levels).

Moreover, the ground station will be mounted on a secured University of Arizona building rooftop in a controlled environment and be inaccessible to the general public and unqualified personnel. Furthermore, safety procedures and/or interlocks will be implemented to assure that when the rooftop area is accessed by authorized personnel that RF emission will be completely disabled.

EXHIBIT 1

[REDACTED FOR PUBLIC INSPECTION]