Space Environment Corporation (FRN 0003-7546-94)
Experimental License Application
Exhibit 1

Ionosonde Operations and Emissions

Emission: M1N, binary phase–coded pulses

Coding: 13–bit Barker code or 8–bit complementary

Bit length: 40 μs

Pulse repetition rate: 40 Hz

Necessary bandwidth: B_n = 60 kHz

Pulse power: 600 W PEP (12.5 W average)

The frequency bands requested in (4) cover the ionosonde operating range but omit sensitive frequencies such as the international distress calling frequency and standard time frequencies. A 30 kHz guard band is included to compensate for the CADI pulse bandwidth.

The 40 μs bit length using a raised cosine pulse yields a necessary bandwidth B_n = 60 kHz (K = 1.2 in §2.202(g), including components down to 30 dB below the fundamental.) The coded pulse length is either 320 μs or 520 μs, depending on the code used.

The ionosonde antenna provides less than 1.2 dBi gain in the main lobe,which is directed towards the zenith, yielding a maximum effective radiated power of 794 W directly above the antenna.

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Exhibit 2

Project: Regional Ionospheric Forecast and Specification (RIFS) for Low-Latitude Navigation and Communications
Contract F19628-00-C-0026

Agency: Air Force Research Laboratory/U.S. Department of Defense

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This project is phase two of a Small Business Innovative Research (SBIR) grant to build a system to monitor and forecast both the background ionospheric state and the degree of ionospheric disturbance in a local geographic sector. The RIFS system uses real-time inputs from several ground-based and satellite instruments to drive an ionospheric model, producing a description of current ionospheric conditions and providing a forecast of conditions and disturbances. The RIFS system will be useful in several navigation and communications applications, including the FAA WAAS system, OTH radars, HF communications, and ionospheric corrections for single-frequency GPS receivers.

This experimental license application covers the operation of an ionosonde to acquire ionospheric bottomside measurements for the RIFS system. The ionosonde operations proposed here are unusual, requiring in general a smaller range of frequencies and less transmission time than traditional scientific ionosonde measurements.

The ionosonde operates like a radar, transmitting phase-coded pulses upwards and receiving reflections from layers of the ionosphere, typically using 10-50 kW pulses. A traditional ionosonde sweeps a wide range of frequencies, e.g. 2-20 MHz, to obtain a virtual height profile of the E and F layers. This process is repeated at intervals ranging from 5 minutes to 30 minutes depending on the measurement objectives.

We propose using a very small ionosonde, the Canadian Advanced Digital Ionosonde (CADI) which operates at much lower power (600 W PEP) than traditional ionosondes. The ionosonde dwells at each frequency for approximately 0.5 second, so a full ionogram from 2-20 MHz at 100 kHz resolution would require approximately 90 seconds to complete. For the purposes of this project, only segments of the full ionogram are required, so transmission times of less than 30 seconds would be typical. The ionosonde will acquire data as often as once every five minutes during critical periods, such as around local sunset, and may operate at much longer intervals (20-30 minutes) at other times. Thus the CADI would be transmitting less than 10% of the time, and on a given individual frequency less than 0.17% of the time.

The CADI will be set up at Utah State University's Bear Lake Observatory (BLO) where a conventional ionosonde (dynasonde) is already operating. The CADI and dynasonde will be operated in an interleaved fashion, allowing the CADI results to be compared to those of the

dynasonde through diurnal and seasonal variations, and hopefully through a wide range of geomagnetic conditions. This will allow us to determine whether the CADI data offers sufficient quality for the RIFS requirements, and to quantify the difference in quality (if any) between the two instruments.

Another goal of the CADI operation will be to determine the narrowest frequency range needed to provide the ionogram data required for RIFS. Rather than acquiring a traditional ionogram by sweeping a wide range of frequencies (e.g., 2–20 MHz), we intend to acquire partial ionograms over some small portion of the range. Since some applications of the RIFS system will be in air traffic navigation, it will eventually have to operate in close proximity to airports; as a result, we particularly want to avoid frequencies used by aeronautical fixed and mobile operations.

The CADI has the ability to monitor the frequencies of interest prior to producing an ionogram, so we will be able to skip over frequencies which are in use; this capability will minimize interference to other spectrum users and will provide cleaner ionograms for our analysis.

In summary, we do not anticipate that the CADI operation will pose a significant interference risk to other spectrum users since it will be operating at a much lower power and over a smaller range of frequencies than the existing BLO dynasonde.

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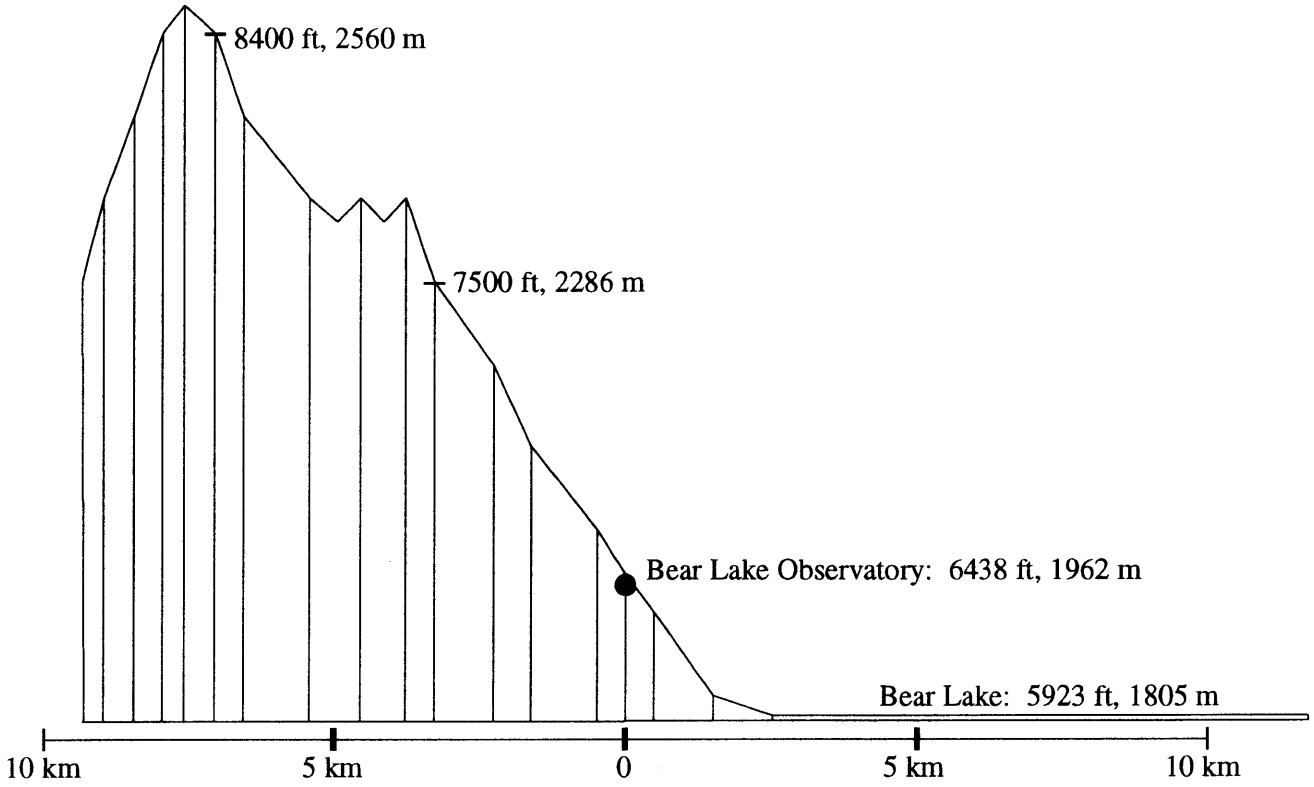
Exhibit 3



Bear Lake Observatory Topography, East–West Elevation

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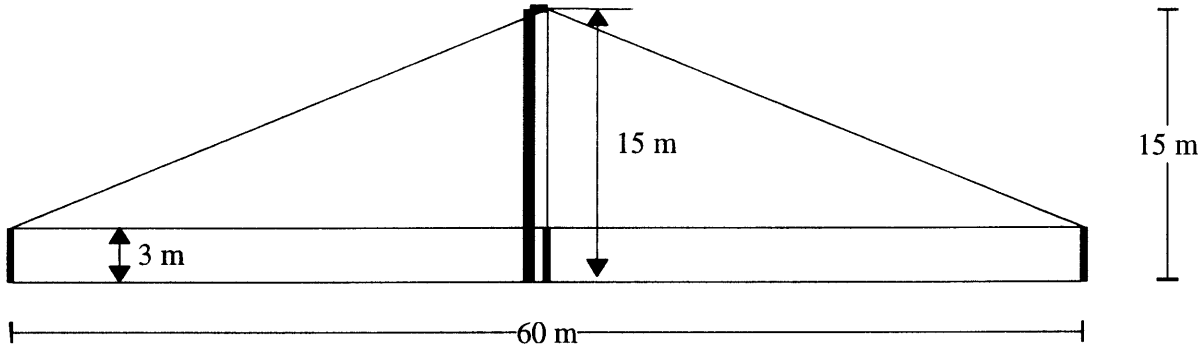
Exhibit 4

Elevation View

Center mast is guyed; end posts are self–supporting. Coaxial cable feedline attaches to antennas via baluns near base of center mast.



Plan View

Ionosonde antenna system consists of two orthogonal delta antennas: one transmit–only, one receive–only. Center load resistor (suspended from mast) is 600Ω, 100 W for each antenna.