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Form 442 File Number 0453-EX-PL-2014

Question 7: Exhibit Detailing Program of Research for Part 5 Application

a. The complete program of research and experimentation proposed including description of equipment and theory of operation.

This is a program of research and experimentation of radio at VLF, LF, and MF wavelengths.

This program is expected to run for a 5 year period. Research into the propagation of radio at these wavelengths, suitability of these bands for one- and two-way automatic (computer controlled) and aural communication, and the effects of the solar sunspot cycle, weather, season, time of day, radiated power and antenna height upon this communication. Modern narrowband signaling methods will be tested and optimized for suitability at VLF, LF, and MF. This communication will be through a radio beacons operated between 27.0 and 517.0 kHz using on/off keying (Morse code) for aural reception, slow Morse code for automatic reception (QRSS), single sideband, narrowband digital voice, and low baud rate phase/frequency shift keying for automatic reception. Both one- and two-way communication will be attempted with other experimental stations and stations in the amateur service. Reception reports and feedback will be solicited in real time via the internet and from amateur radio operators.

The transmitters and other equipment used for this experiment will be custom built. The applicant is the owner/operator of the experimental stations. The transmitter frequency will be synchronized to a GPS disciplined oscillator acting as reference for a synthesizer and operated at VLF, LF, and MF. The transmitters are class-D design using power MOSFETs, and linear ssb exciters capable of being used with digital modes. Operation will be either automatic (computer controlled) or hand keying for CW Morse code and computer generated low speed Morse and frequency/phase shift keying. The antenna will be an electrically short, top loaded monopole (see attached diagram).

b. The specific objectives sought to be accomplished.

Objectives to be accomplished are:

- Study and proof of effective communication in this band using stated techniques.
- Optimization of modern narrowband signaling techniques for long distance very low frequency propagation.
- Study of propagation and suitability of this band for one- and two-way communication.
- Study of effects of solar cycle, weather, season, time of day, radiated power, and antenna height upon this communication.

c. How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion or utilization of the radio art, or is along line not already investigated.

Modern narrowband signaling techniques have not been studied in depth for application to the low frequency range. The use of GPS disciplined frequency control will allow for coherent operation, essential for reception by long time integration of very weak signals in an extremely narrow bandwidth (tens of microHertz).

Newly developed techniques such as WSPR (Weak Signal Propagation Reporter) and WSJT ("Weak Signal Communication, by K1JT") both protocols are being developed by Nobel laureate Professor Joe Taylor of Princeton University which will be evaluated. This research program will test both aural and automatic signaling techniques, and detail their effectiveness and how these techniques are influenced by sunspot cycle, weather, season, time of day, radiated power, and antenna height. In order to capture a statistically significant portion of an 11 year solar cycle it is necessary that this experiment be carried out over a 5 year term. Thus I am requesting a 5 year grant for this experiment.