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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 the 4100m wavelength.

This program is expected to run for a 5 year period. Research into the propagation of radio at 4100m, suitability of this band 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 LF. This communication will be through a radio beacon operated between 68.0 and 75.0 kHz using on/off keying (Morse code) for aural reception, slow Morse code for automatic reception (QRSS) 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 determined by a quartz crystal and operated at LF through division of the crystal frequency or direct digital synthesis. 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 diagrams).

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 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. Research that had been done in radio at the beginning of the last century was consulted, as most of this had been initially at low frequencies before it was discovered that shortwaves were the route to go for long distance communications. There is a lack of information about long distance propagation at LF, i.e. in the 70kHz region. There is a lot of information on VLF where work has continued for submarine communications, and a lot of work at MF to HF for the broadcasting communities, so to some extent there is a gap in our knowledge at LF. 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.