

Exhibit Detailing Program of Research for Part 5 Application and **Purpose of Modification**

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 600m wavelength. This program is expected to run for a 5 year period. Research into the propagation of radio at 600m, 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 MF. This communication will be through a radio beacon operated between 460-480,493-510kHz and 510-515 kHz using on/off keying (cw Morse code) for aural reception, slow Morse code for automatic reception (QRSS), low baud rate phase shift keying and MSK (minimum shift keying) for automatic reception as well as narrowband voice transmissions in the single-sideband suppressed carrier mode. The antennas will be an electrically short, top loaded monopole and electrically small transmitting loop variety.

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 medium frequency propagation.
- Study of propagation and suitability of this band for one- and two-way communication particularly with regard to coherent techniques as applied to Minimum Shift Keying (MSK).
- 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. The lower end of the Medium Frequency range (300-3000 kHz) is characterized by stable ground wave paths with low to moderate path attenuation. This opens up the possibility of reliable communication on a scale of tens to a couple hundred kilometers independent of ionospheric propagation disturbances. Modern narrowband signaling techniques have not been studied in depth for application to the lower medium frequency range. This 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. Of particular interest is the study of the stability of ground wave paths with respect to amplitude and phase variations. Minimum shift keying (MSK), a form of modulation where the phase changes are undertaken at the zero crossing points. By adopting the MSK technique the sidebands and hence the bandwidth required is reduced. It also enables coherent techniques to be used to gain a 3 dB advantage

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- 1) To add antennas in Killingworth, East Lyme, and Enfield, CT as well as in Skowhegan, ME. The additional sites will allow for more robust testing of data modes over various ground wave paths and distances by supplementing the existing network of antennas (sketches for new antennas attached), existing antennas remain unchanged from initial filing.
- 2) To add frequencies 460-480 and 493-505 kHz. This will permit coordination with other experimental licenses in this range. This will enable inter-operability and leverage the infrastructure of existing experimental stations.
- 3) The requested power level was changed from 200W ERP to 1kW ERP. It has been our experience that additional power can be useful during times of high atmospheric static (typically summer).