ATMOSPHERIC & SPACE TECHNOLOGY

RESEARCH ASSOCIATES

11118 QUAIL PASS • • SAN ANTONIO, TEXAS, USA 78249 • • (210) 691-0432

EIN: 20-2946717 DUNS# 60-1975803

Re: Application for Special Temporary Authority
FCC Registration Number (FRN): 0015091481

To Whom It May Concern:

This letter is written in support of an application being submitted to the FCC, and describes the project in detail. A second accompanying letter explains why a Special Temporary Authority is necessary

The request is to operate three transmitters in the Chesapeake Bay area, as part of an HF Doppler radar to measure traveling ionospheric disturbances (TIDs) in the F-region of the ionosphere. The radar operation will support a NASA rocket launch out of Wallops Island, MD. Rationales for the site, frequency and date selection are described in more detail below.

Requested Dates of Operation: The three transmitters would operate near the Chesapeake Bay for a maximum of 12 weeks from August 15, 2006 through November 15, 2006.

Project Description: The radar will operate in support of a NASA rocket experiment, to be launched from Wallops Island rocket range, near Chincoteague, MD. The experiment is highly important to the national interest, as it will help to improve our understanding of ionospheric effects that can seriously impair the operation of surveillance, navigation and communication systems. The rocket experiment will also be supported by Air Force experimental radio systems and personnel.

The radar experiment is supported by NASA Grant NG04WC22G to Southwest Research Institute, San Antonio, TX. The Principal Investigator for the grant is Dr. Rudy Frahm of SwRI. SwRI has hired ASTRA (Atmospheric and Space Technology Research Associates) to deploy and operate the radar, and to analyze the data. The Project Manager is Dr. Geoff Crowley, president of ASTRA. Dr. Crowley is recognized as a leading expert in the field of TIDs and the use of HF radar to detect them, and has worked in this field for over 25 years. Until recently, Dr. Crowley was an employee of SwRI, where he successfully operated similar HF Doppler systems under Experimental Call Sign WC2XRM (File # 0161-EX-PL-2001, and File #0132-EX-RR-2003).

<u>Brief Description of Radar:</u>

One of the most sensitive methods for detecting transient changes in the ionosphere is the HF Doppler technique (Georges 1967). A simple Doppler system consists of a CW (continuous wave) radio transmitter and receiver, which are highly frequency-stable (1 part in 10^7), together with some kind of recording device (e.g. Crowley, 1985). The CW signals are typically transmitted in the HF band between 2-10 MHz. When a HF radio wave is reflected from the ionosphere, movement of the reflection point during passage of a TID produces a change in phase path and a Doppler shift proportional to the time rate of change of the phase path. Although the frequency shift is small, (typically 1 part in 10^7), it can easily be measured by comparison with a standard reference oscillator. A sensitive communications receiver with a narrow bandwidth (~100 Hz) receives the sky-wave signal at a site about 50-100 km from the transmitter and down-converts the signal to a frequency of several Hertz. The Doppler shift of the received signal is thus measured from variations of the receiver output frequency. If three transmitters are used, the spatially separated propagation paths can be monitored, and the time difference between the wave signatures from the three reflection points yields the speed and direction of the TIDs by triangulation.

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Transmitter: Each of the three HF transmitter systems consists of a signal generator feeding a CW signal into an HF amplifier. The amplifier output then feeds a simple dipole antenna, which is installed in an inverted-V configuration. Thus the major lobe of the antenna radiation pattern is in the vertical direction. Because we need to recognize the three transmitted signals at the receiver, frequency offsets of 10 and 20 Hz are applied to two of the transmitted CW signal frequencies. Thus if one transmitter operates at a frequency of 2.62 MHz, the second would operate at 2.620010 MHz, and the third would operate at 2.620020 MHz.

Antenna Height is: less than 6 meters
RF output power at the transmitter terminals is: 100 Watts.
Mean Max Effective Radiated Power is: ~100 Watts
FCC Emission type is: N0N
Necessary Bandwidth is: the transmitted signal only occupies 20 Hz of spectrum.

Receiver: The receiver system consists of 4 Ten-Tec 331 receivers. The radar will operate on two frequencies (applications submitted separately), and both O- and X-modes will be differentiated, so four distinct channels will be analyzed in the system. The baseband audio (with BFO of 1 kHz) outputs from the receivers go into an 8-channel A/D converter (only 4 channels are used) and is processed on a PC. The processed data is logged on a large hard drive for Doppler-data processing. The antenna feeding the receivers is a crossed inverted V dipole (less than 6 m tall) with a quadrature hybrid to separate O- and X-mode components. A highly stable 10 MHz oscillator is used to stabilize the receiver system.

We have deployed and tested the radar (at higher frequencies) in San Antonio, TX. It appears to be working reliably and collecting good data. The radar was interfaced with the data-logging computer, and a real-time display capability was developed and tested. Web-access to the real time displays was also developed. This has been a major development over our previous systems. It was required to enable operations and monitoring from a remote location. It also allows a certain amount of ability to remotely modify and restart the system in the event of software errors. The Web-access and real-time displays have allowed us to monitor and correct problems within hours of their occurrence, rather than the several days or weeks in the past. The complete system is ready for re-deployment to the Chesapeake region.

A typical data set is shown in Figure 1, which shows the Doppler shifts caused by well-correlated TIDs perturbing the radio reflection points on three different transmission paths at different times for January 30th 2002. Time delays between the perturbations on different Doppler paths have traditionally been estimated by the cross-correlation technique, however we developed a cross-spectral analysis technique, which has the advantage of separately examining the time (i.e. phase) delay for each frequency component of a signal (Crowley et al., 1984; Crowley, 1985).

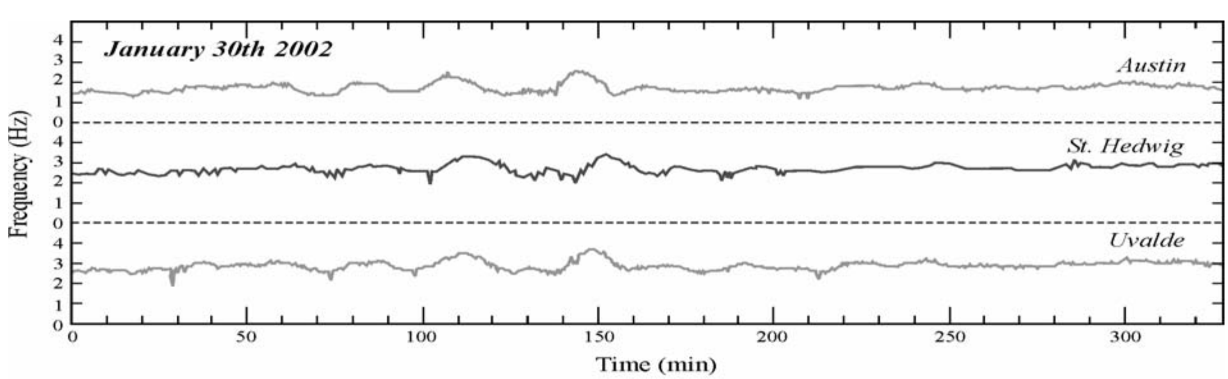

Figure 1: TIDs on three propagation paths for 4.5 MHz sounding frequency on January 30th, 2002.

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Rationale for Transmitter Site Selection:

The rocket will be launched from Wallops Island towards the southeast, and will land in the Atlantic Ocean. The closest point of land to the rocket apogee is near Melfa, VA, where we will locate the receiver for our radar system (see Figure 2). The three sites for the radio transmitters were selected based on the need to (1) have the ionospheric reflection points as close as possible to the rocket apogee; (2) have them arranged in an isosceles triangle around the receiver site at Melfa, MD; (3) have each Tx-Rx separation approximately equal, so the ionospheric reflection heights are similar. Triangulation of the three signals is used to compute the TID velocities.

The coordinates for the requested transmitters are:

1) Ocean City Airport:	Latitude = 38.3108N;	Longitude = 75.1182W
2) Virginia Beach:	Latitude = 36.846N;	Longitude = 76.079W
3) Tappahannock Airport:	Latitude = 37.9221N;	Longitude = 76.8741W
Alternate to Virginia Beach:		
USN Northwest Radio Station	Latitude = 36.557N;	Longitude = 76.2458W

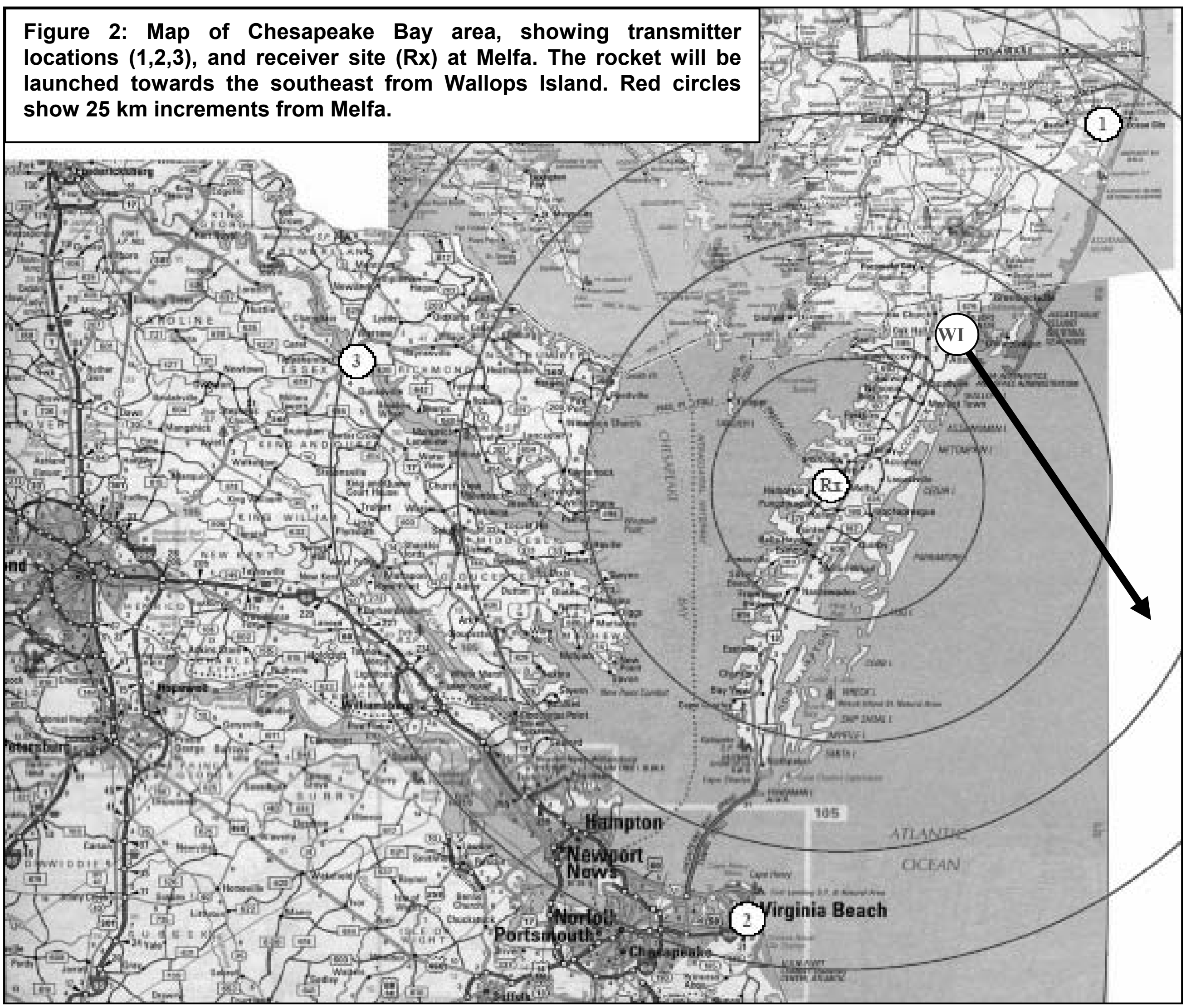

Figure 2: Map of Chesapeake Bay area, showing transmitter locations (1,2,3), and receiver site (Rx) at Melfa. The rocket will be launched towards the southeast from Wallops Island. Red circles show 25 km increments from Melfa.

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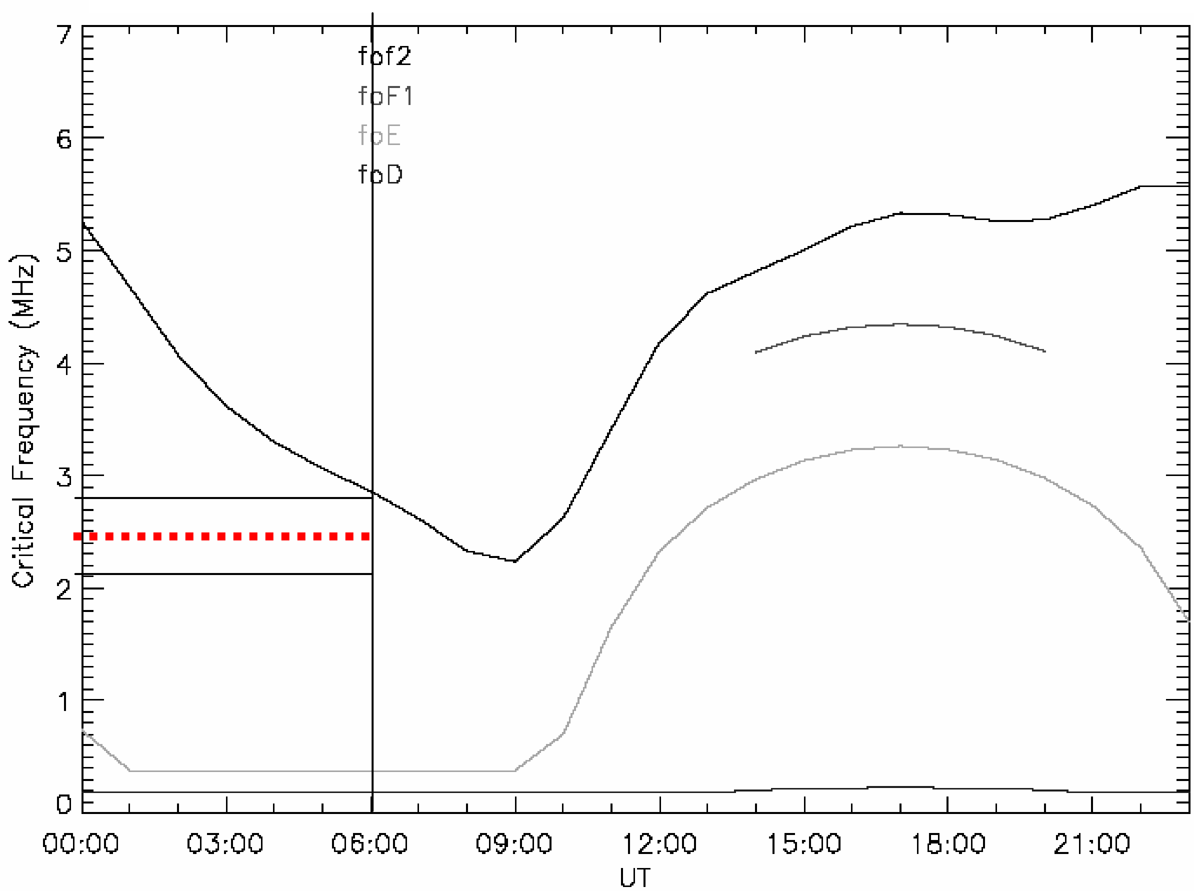
Rationale For Frequency Selection:

We have used the International Reference Ionosphere (IRI) model to predict the ionospheric conditions for Wallops Island during the launch period in the Fall of 2006 (see Figure 3). The irregularities are normally observed in the dusk sector between 00-06 UT, and Figure 1 shows that F-region propagation is only reliably available at frequencies below 2.85 MHz during this time interval. Thus, 3 MHz represents the upper end of our usable frequency range. We do not have specific frequencies we need to operate on, as long as they are below 2.85 MHz. In addition, we plan to operate on two frequencies simultaneously, in order to sample two different reflection heights in the ionosphere - this permits us to deduce the vertical TID velocities. Because of the short amount of time available before the radar is needed by NASA, we are submitting 5 separate requests for frequency allocations for this radar, in case any of the frequencies are problematic for the FCC.

The FCC Frequency Allocation tables show that there is a Fixed/Mobile band available from 2.194-2.495 MHz, and another from 2.505-2.85 MHz. Therefore, our frequency requests will lie in these two bands, excluding the intervening frequency and time bands.

Fig 3: Ionospheric propagation predictions: Wallops Island for September 1, 2006.



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Purpose of the rocket experiment and supporting radar measurements:

The purpose of the rocket and radar is to investigate mid-latitude ionospheric irregularities that can seriously impair radio propagation and systems on all frequencies. It has been suggested that the irregularities are seeded by gravity waves (AGWs) propagating through the bottomside ionosphere. The AGWs perturb the ionospheric electron density distribution, so they can be detected in the form of traveling ionospheric disturbances (TIDs). The proposed radar will provide one of the main criteria for the rocket launch: the radar will detect the presence of TIDs, and it may also detect the presence and growth of F-region ionospheric irregularities.

The proposed HF Doppler experiment will contribute to the most comprehensive dataset ever assembled for the study of mid-latitude Spread-F. Despite the frequent occurrence and long-lived nature of mid-latitude Spread-F, no dataset encompassing all the important variables has been obtained previously. In addition to the *in-situ* rocket measurements of ionospheric irregularities and bulk properties, ground-based instruments will provide a complete description of the background ionosphere. The HF Doppler system contributes important information about the TIDs and underlying gravity waves propagating through the F-region ionosphere at heights of about 200-350 km.

The rocket will fly through a Spread-F event while measuring the large and small scale neutral winds, electric fields, and plasma density variations. In addition, GPS data from a receiver aboard the rocket will help to characterize the medium above the payload throughout the flight. The data gathered during the rocket flight will allow for the first time a quantitative comparison between the F-region radio propagation and TID environment and the rocket "snapshot" of the key environmental variables during a mid-latitude spread-F event. In addition, the ground-based diagnostics will occur over a time span of several weeks than the rocket flight, allowing us to build up a series of observations to help characterize the radio propagation environment during both quiescent and active spread-F periods.

Rationale for Requested Dates of Special Temporary Authority

We request permission to operate the radar starting August 15th, 2006. This allows one month prior to the rocket launch, in order to ensure that the radar is fully operational, and to collect test data for days that do not experience F-region irregularities. The launch window for the rocket is September 15 - October 15, 2006. We further request permission to operate the radar until Nov 15th - this allows several weeks of data collection after the rocket launch, to establish a baseline dataset for comparison with the data obtained during the rocket flight. If the rocket launches early in the launch window, our radar will operate for less than 12 weeks.

Further information about the radar and the experiment is provided in the 2nd accompanying letter with this application. Please contact Dr. Geoff Crowley at ASTRA with any additional questions. The NASA contract monitor for the radar, and the rocket is Dr. John Brinton, who is based at NASA Wallops (tel:757-824-1099). The SwRI PI for the project is Dr. Rudy Frahm (tel: 210-522-3855).

Your help in approving this application would be much appreciated.

Sincerely,

Dr. Geoff Crowley

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