

**Chaos Industries, Inc.**  
**Application for Conventional Experimental Radio License**

**Application Narrative – Amended October 2024**

By this application (“Application”), Chaos Industries, Inc. (“Chaos,” formerly known as Caos Capital, LLC) requests grant of a Conventional Experimental License to operate facilities in the 223-235 MHz band as specified in the Application for a period of two years.

Chaos requests authority to continue testing a prototype radar system to (i) determine the necessary EIRP of a custom radio frequency transmitter device, (ii) measure waveform parameters, and (iii) record the return of the transmitted pulse between two receivers which are spatially in the same location. In particular, Chaos intends to conduct experimental operations to determine how closely it can synchronize receiving a transmitted pulse into two receivers, with the goal of developing precision synchronization of spatially separate RF receivers.

Previously, the FCC granted an Experimental STA for Chaos to operate in the 220-225 MHz band at a site located in Hermosa Beach, California (1832-EX-ST-2023). By a separate application, Chaos is currently seeking a conventional experimental license to continue to test at the Hermosa Beach site (0798-EX-CN-2024). This Application requests a conventional experimental license to conduct additional tests in the 223-235 MHz band from a new site located in Hawthorne, California.

Chaos respectfully submits that the public interest would be served by granting this request for a conventional experimental license with a standard two-year term. Chaos is developing air traffic and maritime radars for the United States Air Force and intends to develop a similar radar product for commercial shipping applications in addition to commercial air surveillance. To aid in product development, Chaos needs access to the requested frequencies from the Hawthorne location. Such access is necessary in order to complete research and development of radar phenomenology where Chaos intends to test different receive signal processing algorithms on the transmitted radar pulse, by using the unpopulated mountain-top mentioned as a reflector.

As stated in its prior applications, Chaos intends to aim the main beam at a portion of elevated ground at an unpopulated mountain-top located approximately 19 kilometers away (Lat: 33.79241238647887; Long: -118.40244467886235), at an elevation of approximately 220 meters above ground level, and measure the backscatter. Testing the proposed frequency band at the new location will provide additional data points for the conducted tests.

Chaos continues to develop and refine new signal processing algorithms that will increase its ability to detect and receive the transmitted pulse signals. No change to the transmission equipment previously authorized in the STA Authorization will be necessary, and the technical information provided in the STA Request, as amended, remains true and correct.

Approval of the instant request will permit Chaos to continue testing a new prototype radar device that can be used to enhance public safety and support the application of new technological approaches in the radar systems.

**Contract Information:** The operations proposed in this Application are supported by, and the authorization will be used for fulfilling obligations of a contract with, U.S. Air Force Research Laboratory/AFWERX under Contract No. FA864924P0424. The contract points of contact are Thomas Shea ([thomas.shea.3@us.af.mil](mailto:thomas.shea.3@us.af.mil)) and Joshua Ortiz ([joshua.ortiz.3@us.af.mil](mailto:joshua.ortiz.3@us.af.mil), 937-713-9886).

**Technical Specifications:**

1) Frequencies Desired: Chaos requests authorization to operate on the frequency specified in the Application:

- a) 223-235 MHz – max bandwidth: 12 MHz

The specified frequency was intentionally selected to eliminate any conflicts with:

- a) public safety licenses,
- b) spectrum allocated for aeronautical purposes which would require pre-coordination with the Federal Aviation Administration, and
- c) Broadcast television operations in the 210-216 MHz band.

2) Transmit and Effective Radiated Power Levels: The unit to be tested will operate with a range of transmit power levels, beginning with 1 watt. The Application specifies a maximum transmit power of 1000 W, and a peak maximum effective radiated power of 3981 W.

Chaos intends to continue using an Ettus software-defined radio, along with commercially available, off-the-shelf RF components, including (i) an amplifier (creating up to 3981 watts of EIRP using the 9.5 dBi antenna), (ii) bandpass filters, and (iii) a TV-style VHF antenna with a 70-degree wide main beam. The Antenna Gain is 9.5 dBi in the main beam.

3) Modulation and Emissions: The unit is capable of operating with either frequency or phase modulation. The Application specifies emission designators for both frequency and phase modulations.

4) Antenna Information: The antenna will be mounted in a manner that will not require prior approval under FAA or FCC rules and regulations.

- a) Width of beam in degrees at the half-power point: a) H-Plane: 140 degrees; b) E-Plane: 70 degrees;

b) Orientation: Chaos intends to radiate either in full horizontal polarization or full vertical polarization at any given time, but not both simultaneously. In the vertical plane, we will be oriented to point from 0 degrees up to 60 degrees off the horizon.

c) The Antenna Gain is 9.5 dBi in the main beam

d) The Azimuth Direction is 182.25 degrees from fixed site to target.

5) Operations: Chaos will conduct the proposed tests with no more than one (1) unit operating at a time. The unit will operate with up to a 20% duty cycle, and transmissions will be no more than 200 milliseconds long. It is expected that the testing of the unit will be no more than 1 hour per day, at intervening periods during the license term.

6) Radiation Hazard Analysis: Chaos has confirmed that the proposed operations will comply with the FCC's RF exposure guidelines with respect to the prototype antennas and test station transmissions, for uncontrolled (general population) and controlled (occupational) environments, as specified by Section 1.1310 of the Commission's rules.

Our radiation hazard analysis shows that in the worst case, our antennas location for 223-235 MHz will be 4 meters above the closest walkway at the 2 meters over ground level (2 meters is pedestrian height estimation), so that the antenna will be 6 meters overall above ground level, where the general population would be exposed to the RF. The walkway is 3 meters away in the worst case, resulting in a slant range to the general population of 5 meters, again conservatively and in the worst case.

In particular, the testing will occur on private property, with restricted access only to authorized personnel. The transmitting antenna will be installed on the roof of a building, at least 30 feet above any area where the general public or any occupational workers will be located. The center and peak gain of the 223-235 MHz antenna main beam of 9.5 dBi will be pointed towards the sky at an angle greater than 40 degrees above the horizon, such that no part of the main beam will hit any area where the general population or occupational workers will be located. Therefore, the general population will be at a 93 degree angle from where our antenna is pointed. The gain at this angle of 93 degrees to the general population is -3.5 dBi. We plan to use a 1000- watt power amplifier. As a result, - 3.5 dBi at a slant range of 5 meters results in approximately 1.42 W/m<sup>2</sup> power density and approximately 23.1 V/m field strength, less than the 2 W/m<sup>2</sup> and less than 27.5 V/m electric field strength for 223-235 MHz. The transmissions will be for very short periods of time, no more than 200 μs pulse, and a 20% duty cycle, for no more than a few seconds at a time.

The next closest walkway is approximately 10 meters slant range behind the antenna, located within the back lobe of the antenna, where the gain is approximately 0 dBi in that direction. As a result, utilizing the 1000-watt power amplifier with a 0 dBi of gain at 10 meters away is approximately 0.83 W/m<sup>2</sup> power density, and 17.4 V/m electric field strength, both well below the FCC's general population/uncontrolled exposure limits at these frequency bands.

With respect to the unpopulated mountain area where we will point the main beam, we anticipate that a portion of the beam 4 dBi down from the peak/center of the main beam will hit the mountain top. With a 1000-Watt power amplifier, a 9.5 dBi peak main beam (5.5 dBi worth of gain in the direction of the mountain top), at 24,000 meters away, if any general population were present in this area, they would receive about 0.023 V/m, well below the FCC's general population/uncontrolled exposure limits at these frequency bands.

Hence, any transmissions will not occur in proximity to and will comply with the exposure limits with respect to the general population. All Chaos personnel operating and maintaining the equipment will be trained on proper handling of the equipment to mitigate radiofrequency exposure. Our occupational workers will be inside our building when the RF is transmitting, behind the antenna, such that minimal radiation is received, also well below both the FCC's general population/uncontrolled and the occupational/controlled exposure limits at this frequency band. Furthermore, all transmissions will be positively controlled by Chaos personnel during testing who will be able to cease transmissions at any time.

### **Interference Mitigation:**

Chaos is well aware of its obligations under Part 5 of the Commission's rules to avoid interference to co-channel licensees in non-experimental services, and will take all necessary steps to ensure compliance with this obligation. Should interference occur, Chaos will take immediate steps to resolve the interference, including discontinuing operations if necessary. To date, no interference complaints have been received during the STA period.

In addition, the following factors will help mitigate any interference issues:

1. Each test will be limited in time and location to protect other spectrum users.
2. Emissions will be active for short durations no longer than 1 minute at a time. During a test, emissions will be activated periodically, and will not be continuous.
3. The site specified in the Application is approximately one (1) kilometer from the closest airport runway. Chaos will ensure that minimal energy is directed at the airport. Chaos will coordinate with the airport to cease operations during any scheduled departures and arrivals as necessary. Additionally, the airport will have the stop buzzer information provided below.
4. A waiver of the Station ID requirements of Section 5.115(a) of the Commission's rules is requested.

### **Stop Buzzer:**

The following will be available by wireless telephone and will act as the "stop buzzer" if any issues arise during testing:

- Primary: Bo Marr – Mobile: 310-487-5016;
- Secondary: Daniel Thompson – Mobile: 405-388-0692.