

### **Description of Program of Research**

Caterpillar of Delaware, Inc. (“CAT”) is a major manufacturer of diesel motors, heavy construction equipment as well as mining and specialty equipment. Testing of new products and product improvements is conducted at CAT’s Peoria, Illinois and Green Valley, Arizona proving grounds. CAT has developed heaving equipment that rely on computer modules as well as equipment that is designed to work autonomously on a Wi-MAX system in mining applications. Additionally, CAT has other equipment under development that can make use of the Wi-MAX system as well as other radio frequency bands.

The purpose of using computer modules in its heavy equipment and motors is to ensure that these devices operate efficiently and properly. Additionally, for those devices that are radio controlled, the purpose is to protect personnel from injury or death by automating the operation of equipment in extremely hazardous environments such as certain mining applications.

This Experimental Radio Service license modification application will support CAT’s on going electromagnetic (“EMC”) immunity testing of Caterpillar, Inc. products. This testing is necessary to ensure product safety and to comply with regulations in certain countries and the European Union<sup>1</sup> in which CAT offers its machines for sale. EMC immunity testing involves placing a transmitting antenna on or near the equipment under test (“EUT”) and generating an RF signal with an RF signal generator and amplifier. This experimentation supplements EMC testing that is performed in an absorber-lined shielded enclosure. Additionally, given recent hacking events involving motor vehicles, this experimentation will also provide CAT with the opportunity to test the security of its equipment from outside hacks. However, the size of some of CAT’s products makes testing in a shielded enclosure difficult or impossible. This license modification is requested to allow necessary testing of products that are not easily tested in a shielded environment in order to ensure product safety, quality and regulatory compliance.

#### *Duration*

A license term of 5 years is requested, since products are tested on an ongoing (although very intermittent) basis. Total operation time on any one frequency is expected to be less than 3 hours per month.

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<sup>1</sup> See e.g., EU EMC Directive (2014/30/EU) and EU Safety Directive (2006/42/EC).

*Frequencies*

Although a large range of permitted frequencies have been requested in the 2 GHz band, actual testing will be done on discrete frequencies between 2.0 – 2.70 GHz in steps of 40 MHz (i.e., 2.0 GHz, 2.04 GHz, 2.08 GHz, 2.12 GHz, 2.16 GHz, 2.20 GHz, 2.24 GHz, 2.28 GHz, 2.32 GHz, 2.36 GHz, 2.40 GHz, 2.44 GHz, 2.48 GHz, 2.52 GHz, 2.56 GHz, 2.60 GHz, 2.64 GHz, 2.68 GHz and 2.70 GHz). To minimize the potential of interference to licensed wireless operations, the FCC license database will be consulted when selecting frequencies for testing.

*Power Levels*

EMC immunity testing requires uniform field strength to be generated across the frequency range of interest. This means that, in theory, the effective radiated power (ERP) across the frequency range should be the same. However, transmitter output power will vary across the frequency range depending on the efficiency of the broadband antenna at any given frequency. At low frequencies where the transmitting antenna is an inefficient radiator, the transmitter output power will be much greater than the ERP due to high-reflected power. On the other hand, at high frequencies where the transmitting antenna has significant gain, the transmitter output power will be much lower than the ERP. The requested transmitter output power is the maximum that will be required at low frequencies. At most frequencies, transmitter output power will be much less than this maximum.

*Conclusion*

Grant of the instant application in support of CAT's experimentation will contribute to the development of safer heavy construction equipment and machines by ensuring that on-board computers will not interfere or cause interference to other devices and machines or malfunction due to interference from other RF sources.