

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 facility at Clayton, North Carolina. CAT has developed heavy equipment that rely on computer modules as well as equipment that is designed to work autonomously on a Wi-MAX system in mining operations. Additionally, CAT has other equipment under development that can make use of Wi-MAX and other wireless technologies and frequency bands. As part of this development, CAT is seeking to test its equipment by utilizing LTE on spectrum that would otherwise be commercially available to end-users.

The purpose of using computer modules LTE devices 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 application will allow CAT to test machines using Radiated Immunity Testing protocols on its products and prototypes in order to determine the propagation and performance characteristics of a variety of wireless devices and systems to be used by CAT’s machines. This testing is necessary to ensure product safety and compliance with regulations in certain countries and the European Union¹ in which CAT offers machines for sale. The European Union recently updated its EMC & Safety directives, which require CAT to ensure that its products will operate correctly in the presence of electromagnetic fields. Test method ISO13766 provides the test methods and acceptance criteria for the evaluation of the electromagnetic compatibility of earth-moving machinery as defined in ISO 6155. Further, CAT is required to develop a field strength of 30V/m at a distance of 1 meter from the machine at frequencies between 1 GHz and 2 GHz. At 1 GHz, this field strength will be developed and held for 2.5 seconds, at which time the field will be withdrawn and the frequency adjusted up by 2% and the field developed and held for 2.5 seconds again. The testing regimen requires that this rubric be repeated until all spectrum between 1 GHz and 2 GHz has been tested. In addition to the 1.0 – 2.0 GHz band, it will also be necessary to conduct this testing in the 2.0 – 2.7 GHz band.

While it would be ideal for CAT to be able to test its devices in a shielded enclosure, this is not practical due to the size of some of CAT’s products. The license requested herein will permit CAT to make the necessary testing of its products that cannot be feasibly

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

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tested in a shielded environment in order to ensure product safety, quality and regulatory compliance.

The system will be located on a fixed EMC pad, consisting of an amplifier, signal generator, power meters and an antenna. When the system is in use, it will be placed on the testing pad and moved between the four pre-designated locations² on the pad in order to test the machines from different directions. The specific orientation of the antenna in each location on the pad will depend upon the size and orientation of the particular machine that is being tested as well as its position on the pad. As a result, the maximum beamwidth at any moment in time during the testing will vary from test sequence to test sequence.

Response to Item No. 15 – Owner and Operator

CAT has indicated in the affirmative that it will own and operate the station even though it will not own the equipment and instrumentation that is used for the experiment. In this regard, it is important to note that while the equipment and instrumentation is being provided by its third party contractor, CAT will be the operator of the station when it is in use for testing its machines inasmuch as CAT will supervise the physical operation of the equipment by its third party contractor during any testing scenarios.

Duration

A license term of five (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 1 minute per month.

Frequencies

Although a large range of permitted frequencies have been requested between 1 GHz and 2 GHz, actual testing will be done on discrete frequencies between 1.0 and 2.0 GHz in 2% frequency increments in order to comply with the testing rubric imposed by the European Union and other countries under test standard ISO11451-1. The required frequencies are, as follows:

1000.0000 MHz, 1020.0000 MHz, 1040.4000 MHz, 1061.2080 MHz, 1082.4322 MHz, 1104.0808 MHz, 1126.1624 MHz, 1148.6875 MHz, 1171.6594 MHz, 1195.0926 MHz, 1218.9944 MHz, 1243.3743 MHz, 1268.2418 MHz, 1293.6066 MHz, 1319.4788 MHz,

² As shown in Exhibit 2 and the associated Plat, CAT will be utilizing four locations at its testing facility in Clayton, North Carolina. Because of the close proximity of these locations, the geographic coordinates for all four locations would be identical to that which is specified on FCC Form 442.

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1345.8683 MHz, 1372.7857 MHz, 1400.2414 MHz, 1428.2462 MHz, 1456.8112 MHz, 1485.9474 MHz, 1515.6663 MHz, 1545.9797 MHz, 1576.8993 MHz, 1608.4372 MHz, 1640.6060 MHz, 1673.4181 MHz, 1706.8865 MHz, 1741.0242 MHz, 1775.8447 MHz, 1811.3616 MHz, 1847.5888 MHz, 1884.5406 MHz, 1922.2314 MHz, 1960.6760 MHz, 2000.0000 MHz

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, 2.36 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.

Emission Designator

The emission designators are 100KN0N and 100KP0N.

Power Levels

Radiated 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 even though the transmitter output power will vary – depending upon the efficiency of the 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.

Stop Buzzer Contact Information

George Yeargin, BCP Engineer for CAT, is the technical contact for this request. Mr. Yeargin will be responsible for the operations to be conducted and, in accordance with Rule Section 5.308, will be the “Stop Buzzer” point of contact that is available at all times during the operation of each experiment conducted under the requested license in the event that operations must be terminated due to interference concerns. Mr. Yeargin can be reached at 919-280-5596 or by e-mail at Yeargin_George_D@cat.com.

Compliance with Human Exposure Limits

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CAT certifies that it will operate its experimental facilities in full compliance with IEEE C95.1 – 1991, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.” All personnel who operate the equipment are knowledgeable as to the effects of RF energy and will have the ability to control their exposure.

Conclusion

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