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SUMMARY

Kohler Co. (“Kohler”) requests a waiver of Sections 15.205(a) and 15.35(b) of the Commission’s rules, 47 C.F.R. §§ 15.205(a) and 15.35(b), to allow Kohler to import and market its ventilating toilet kit (“Device”). The Device uses a wideband RF signal to detect the presence of a user on the toilet seat and automatically triggers the operation of an air filtration system.

This device will satisfy the consumer demand for a toilet that ventilates odors and will not cause interference to other existing spectrum users. Measured emissions from the device are very low, since it is designed to detect the presence of an individual only a short distance away, and the emissions are spread over a large bandwidth. Moreover, distances to victim receivers are likely to be very large. Finally, the device will be operated from AC power and will be located inside a toilet and inside a bathroom which, in turn, will be located inside a residential dwelling. Thus, its already low emissions levels will be further attenuated by passing through the toilet, and the walls, ceiling and roof of a residential dwelling. Accordingly, there is virtually no chance that operation of this device will interfere with other spectrum users.

Grant of the requested waiver will permit Kohler to satisfy consumer demand for a device that ventilates toilet odors, will provide a real-world test of a promising technology, and will not generate interference with other users. For these reasons, the requested waiver should be granted.

Kohler is a large manufacturer of commercial and residential bathroom products and plumbing supplies. Over the years, Kohler has done extensive market research into consumers' preferences with respect to new bathroom products. Its market research has

demonstrated that the second most-desired product is a toilet that ventilates odors.¹ One impediment to the development of such a device has been the difficulty in devising a mechanism that activates the fan in the presence of a user without cumbersome and expensive sensors or switches. Traditional sensors used in other bathroom applications rely on infrared technology or manual switches to activate them. Such switches and sensors must be placed outside the toilet tank or require significant modification to the toilet tank making it inappropriate for the retrofit market, and also require wiring and installation procedures that are beyond the capabilities of most consumers.

In late 1994, Kohler became aware of the development of a new ultra-wideband (“UWB”) technology that uses very low power radio waves that can penetrate material like the ceramic used in toilet tanks and sinks. Use of this technology to activate a self-contained device that eliminates bathroom odors would allow Kohler to produce a ventilating toilet kit that an average consumer could place inside a tank and then simply plug in to a nearby electrical outlet. In 1997, anticipating a large consumer demand for such a ventilating toilet kit, Kohler licensed the UWB technology necessary for such a device from Lawrence Livermore Laboratories. Shortly thereafter, in consultation with a consulting engineering firm, D2M, Inc., Kohler developed two devices based on the UWB technology it had licensed from Livermore. One was an actuator for commercial toilets and other bathroom fixtures and faucets, and the second was the Device, which is designed to be installed by consumers in toilets located in residential bathrooms. Kohler then filed two applications for equipment authorization – one for the commercial version

¹ The most desired product is an automatically lifting toilet seat.

and the second for the Device². The Commission granted both applications without raising any questions with Kohler about the compliance of either unit with the Commission's Rules.

Upon receipt of the grant for the Device, which was the second of the two grants, Kohler displayed it at the Kitchen and Bath Industry Show in April of 1999. It was voted the best new product in that show, and Oprah Winfrey demonstrated the Device on her show, which aired on May 5, 1999, and again on July 26, 1999. After this initial publicity, Kohler received approximately one hundred inquiries per week for six months about the Device, which confirms its popularity. During the spring of 1999, Kohler implemented plans to manufacture the Device and anticipated meeting a growing consumer for the Device.

On June 22, 1999, Kohler received a letter from the Acting Chief of the Equipment Authorization Division (the "EAD") of the Office of Engineering & Technology requesting a sample of the Device. Kohler complied and shipped the Device to the Commission. On August 13, 1999, the EAD advised Kohler that the Device was not in compliance with the FCC's technical rules in that its operating bandwidth included the restricted bands 5.35 to 5.46 GHz and 4.5 to 5.15 GHz, which is prohibited by Sec. 15.205 of the Commission's Rules, 47 C.F.R. § 15.205.³ Since then, Kohler has spent a considerable amount of time and money to arrive at a means to modify the Device to

² An application for equipment authorization for the commercial device was filed with the FCC in late 1998 and granted on January 27, 1999. The application for the Device was filed on March 5, 1999 and granted on April 14, 1999.

³ This is in spite of a notation on the equipment authorization application stating: "[d]ue to the width of the fundamental emission some energy is present in the restricted bands of 3.6-4.4 GHz, 4.5-5.15 GHz and

allow it to comply with the Rules.⁴ Kohler, its consulting engineer, and its outside attorneys have met with OET staff on several occasions and have communicated with OET by telephone and letter but have not been able to arrive at a solution which will permit the device to function effectively and comply with the Rules. Therefore, Kohler is hereby petitioning the Chief, OET for a waiver of Sections 15.205(a) and 15.35(b) to allow it to import and market the Device.

The Requested Relief

As indicated above, the Device activates an air-filtering system from within the tank of a standard toilet using a wideband pulsed-RF motion sensor to detect the presence of a user on the toilet seat and relies on the short pulse to pick up user motion. The Device operates with a center frequency of 5.8 GHz. The field strength at the peak of the emission (5.8 GHz) is 48.1 dB μ V/m at 3 meters when measured with a 1 MHz RBW and an average detector. The emission is 895 MHz wide 3.9 dB below the peak, indicating that the effective pulse width is 1.1 nsec. The width of the main lobe of the emission, between the first theoretical nulls is 1.79 GHz. The short pulse emitted by the Device requires a large pulse desensitization correction to determine the instantaneous peak value. In this case, with a 1.1 nsec pulse at a 1 MHz repetition rate, the pulse desensitization correction is 59.2 dB, and the instantaneous peak field strength is 107.3 dB μ V/m. The Device will incorporate a 1 GHz filter, which will produce more

5.35-5.46 GHz, this energy is not necessary for the performance of the device, but could not be practically filtered without affecting the necessary transmission, as explained below.”

⁴ Kohler does not seek here to challenge the Commission’s action with respect to the commercial unit.

than 6 dB of attenuation for components greater than 850 MHz from the center frequency of 5.80 GHz.

Operation of the Device results in a theoretical incursion into the restricted band at 5.35 – 5.46 GHz. However, the risk of actual interference is virtually non-existent. The Device will be located inside a toilet tank, which provides approximately 3 dB of attenuation at these frequencies, and the interior and exterior walls and the ceiling and roof of the house provide additional attenuation. Further, the equipment is AC-powered and is designed to operate only inside a residential bathroom, so the distances to victim receivers in this restricted band are very likely to be large (at least a few hundred meters). In tests conducted at Compliance Certification Services, the transmitted signal was not detectable with a suitable preamp at 3 meters distance in an open field, so it is unlikely that it would be detectable outside a house after being attenuated by the toilet tank and house walls. Further, the antenna has some directivity, and the peak radiation is emitted in the horizontal plane, with the emission in the vertical direction reduced by an additional 5 dB.

The highest measured emission from the equipment was 250 $\mu\text{V}/\text{m}$ at 3 meters in a 1 MHz RBW. For example, with respect to an aircraft operating at a distance of 300 meters above a unit operating inside a toilet inside a house, we would expect about:

$$E_w = (250mV / m) \times \left(\frac{3m}{300m} \right) \times 10^{(-3-3-5)/20}$$

$$= 0.7mV / m$$

of interference to a receiver with 1 MHz of bandwidth. The three attenuation factors above are: 3 dB through the toilet tank; 3 dB through the ceiling and roof of the house; and 5 dB for the antenna pattern.

The emission is broadband, so the amount of interference experienced by a given victim receiver is much less than the peak instantaneous field strength. For example, a receiver with a 1 MHz bandwidth, with this unit 3 meters away and with the peak of its antenna pattern directed toward the receiver, would experience interference levels similar to those seen by the spectrum analyzer in the emissions testing (48 dB μ V/m at 3 meters).

The –20 dB bandwidth of the emission from this unit covers the frequency range from approximately 5.0 to 6.6 GHz. There are several licensed terrestrial users of this spectrum space:

Instrument Landing Sys.	5000–5250 MHz	(250 MHz Band)
Private Land Mobile	5250–5650 MHz	(400 MHz Band)
Aircraft RADAR	5350–5640 MHz	(290 MHz Band)
RADAR	5470–5650 MHz	(180 MHz Band)
Amateur	5650–5925 MHz	(275 MHz Band)
TIRS	5850–5875 MHz	(25 MHz Band)
Fixed Microwave	5925–6875 MHz	(900 MHz Band)

In addition, there are several satellite services:

Big LEO FSS Uplink	5091–5150 MHz	(59 MHz Band)
Big LEO FSS Downlink	5150–5216 MHz	(66 MHz Band)

GSO/NGSO FSS Uplink	5850–5925 MHz	(75 MHz Band)
C-Band Big LEO Uplink	5929.5–5930.5 MHz	(1 MHz Band)
Big LEO Uplink	6500–6855 MHz	(355 MHz Band)

There are several factors common to all these services which mitigate any interference possibility from this device:

- § First, the receivers in these services are not located in residences, where this unit would operate. The Device’s signal is attenuated in passing through the toilet tank , house walls, ceiling and roof. As noted above, this attenuation amounts to about 6 dB through the toilet tank and one house wall.
- § Second, the emission from this unit is inherently spread over a much greater bandwidth than is allocated for any of these services, which bandwidth is in turn much greater than the typical receiver or channel bandwidths employed. Thus, there is a large reduction in the amount of signal received by a victim receiver, proportional to the ratio of the bandwidth of the receiver to that of the emission (approximately 2 GHz).
- § Third, the distances from any of these units to receivers in these services are large (likely several hundred meters). This product is not suitable for installation in commercial buildings or aircraft, and receivers in most of the above services are typically colocated with transmitters, with the resulting need to fence off the area as protection against RF exposure. Therefore, it is very unlikely that residences will be located close to such facilities.

Since only a small portion of the peak transmitted radiation falls within the bandwidth of a potential victim receiver, the peak interference received quickly falls with

distance to levels allowable under Section 15.209 of the FCC Rules. For these frequencies, this limit is 5,000 $\mu\text{V/m}$ at 3 meters. For example:

- § A Fixed Microwave receiver with a 30 MHz bandwidth, operating at 5925 MHz near the peak of this unit's emission, would have to be located less than 3 meters away from the unit to receive an amount of interference equal to the Section 15.209 peak limit, considering the 6 dB attenuation through the toilet tank and house, and the ratio of the 30 MHz receiver bandwidth to the emission bandwidth.
- § A Big LEO Downlink receiver spanning the entire 66 MHz band from 5150–5216 MHz would have to be located about 2 meters away from the unit in order to have the received interference exceed those from a narrowband device at 3 meters emitting at the limits in Section 15.209, considering the 6 dB toilet/wall attenuation, the bandwidth ratio, and the shape of the emitted spectrum (at least 7 dB below the peak at these frequencies).
- § An Amateur receiver with 50 MHz of bandwidth at the center frequency of 5.80 GHz would have to be located less than 4 meters from this device to have the interference exceed the 15.209 levels, considering only the toilet/wall attenuation and the bandwidth ratio.

The above examples are conservative, in that they assume the device is oriented so that the peak emission direction is aligned with the victim receiver, and use the theoretical peak value of the transmitter emission, with full pulse desensitization applied. The average emission from this device, as noted above, complies with the limits in Section 15.209, even without taking into account the toilet/wall attenuation. Even without

applying those factors, it is clear that the distance between this device in operation and any of the receivers used in the licensed services is sufficient to prevent any interference from occurring.

For receivers in all the above services, the signal levels are such that, even if they were detectable (a proposition Kohler sees as extremely unlikely), at worst they would result in only a marginal increase in the noise floor. None of the pulses from these devices are coordinated, so the emissions from multiple devices will add in a noiselike, incoherent, manner, and emissions from the Device are lower in average field strength than unintentional radiators allowed under existing Part 15 rules. Thus, there is virtually no risk of interference to other users.

The emissions from this equipment are also well away from the GPS frequencies and other sensitive frequencies below 2 GHz, and other than the emission into the restricted bands and the high peak-to-average ratio of the transmission, the Device is otherwise compliant with the general radiated limits in §15.209.

The requested waiver of 47 CFR Section 15.205(a) would allow the emission of radiation which might not meet the definition of “spurious” in Section 2.1 of the rules into the restricted bands that exist from 4.5 – 5.25 GHz and 5.35 – 5.46 GHz. The requested waiver of 47 CFR Section 15.35(b) would increase the limit on peak emissions (with full pulse desensitization applied) from 20 dB above the average limit to 60 dB above the average limit.

Conclusion

Grant of this waiver request will further the public interest by allowing Kohler to meet the needs of consumers for a device which eliminates odors from bathrooms and the surrounding environment. It will also provide an additional real-world test of a promising new technology⁵ in an environment that is highly unlikely to cause interference to any other spectrum users. The interest generated by the exhibition of the device and its acclaim following the broadcast of the Oprah Winfrey Show confirm the accuracy of Kohler's preliminary research showing the desire for such a device.

The Commission previously has granted limited waivers to allow Time Domain Corporation⁶, U.S. Radar Inc.⁷, and Zircon Corporation⁸ to operate ultra-wideband devices. A grant of the instant waiver will further help the Commission assess the impact of UWB devices on the RF environment and will meet a demonstrable consumer need.

Given the extremely low radiated power emitted from the Device and the isolation of the device due to its placement inside a toilet tank which is located inside a bathroom which is further encased in a house, there is a very low probability of interference to other users. Thus, Kohler requests a waiver of Section 15.205(a) to allow radiation which may not meet the definition of "spurious" into the restricted bands at 4.5-5.25 and

⁵ See, Separate Statement of Commissioner Susan Ness, in Re: Principles for Reallocation of Spectrum to Encourage the Development of Telecommunications Technologies for the new Millennium, FCC 99-354, rel. Nov. 22, 1999 [get FCC Rcd cite from Lexus], at para. 4.

⁶ See, Letter from Dale N. Hatfield, Chief, Office of Engineering & Technology, to David E. Hilliard, Esq. dated June 29, 1999.

⁷ See, Letter from Dale N. Hatfield, Chief, Office of Engineering & Technology, to Mr. Ronald C. LaBarca.

⁸ See, Letter from Dale N. Hatfield, Chief, Office of Engineering & Technology, to Mr. Terry G. Mahn dated June 29, 1999.

5.35-5.46 GHz and a waiver of Section 15.35(b) to allow the Device to operate with a limit of up to 60 dB above the permitted average on emissions.

It is well established that waiver of Commission rules is appropriate if special circumstances warrant deviation from the general rule and such a deviation will not undermine the policy the rule was intended to serve. See, Zircon waiver at p. 1, citing *WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir. 1969). See also, *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990). Grant of the instant waiver request will meet those criteria.

In light of the above-mentioned considerations, the Chief of the Office of Engineering & Technology should grant the requested waiver of Sections 15.205(a) and

15.35(b). Authority for grant of this waiver is contained in Sections 0.31(i) and 0.241 (a) of the Commission's Rules, 47 C.F.R. Sections 0.31(i) and 0.241 (a).

Respectfully submitted,

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